DEVELOPMENT OF ESSENTIAL OIL INDUSTRY IN UTTAR PRADESH

H.B.Technological Institute, KANPUR

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OF
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A Summary of the work done under Essential Oil Scheme at H. B. Technological Institute Kanpur.

PHOTOGRAPH NO. 1

A general view of the garden

FOREWARD

The manufacture of essential oils and attars has been carried out in India since times immemorial and the Indian products have been popular for their quality and aroma throughout the world. Our State has always been a pioneer in this industry and Kannauj, Jaunpur, Ghazipur, villages of Barmana and Hassayan in District Aligarh etc. have been the famous centres of production. Large quantities of essential oils and attars have been exported to western countries. With the development of essential oil industry in the Western countries on modern scientific lines, the Indian Industry has received some set-back due to the higher cost of production and lower yield of the oils on account of lack of modern equipment and improved methods of manufacture.

The total export of essential oils from India is worth about Rs.1.25 crores per annum and the value of essential oils including attars and perfumed oils produced in the country is about Rs.4.5—5 crores per annum. India also exports essential oil bearing seeds amounting to nearly Rs.50 lakhs and spices worth Rs.18.5 crores per annum.

The introduction of synthetic essential oils and aromatic chemicals, which are cheaper in cost and have an aroma somewhat similar to those of natural oils, have revolutionised the essential oil industry. India imports synthetic essential oils worth Rs.40 lakhs per annum, and some natural essential oils e.g., peppermint, camphor, lavendar, cloves and bergamot etc. worth Rs.75 lakhs per annum.

The State of Uttar Pradesh has been mainly responsible for the development of this industry in the country and the improvements in the existing methods of extraction of essential oils and modernization of equipment would go a long way towards the progress of this industry as a whole. Considering these points, the Government of Uttar Pradesh sanctioned a scheme for the development of essential oil industry in the State in the year 1948-49. Since then the work on this scheme has been intensively done at H. B. Technological Institute, Kanpur.

The State Government had also deputed one of the officers of the Institute to study the methods of distillation of essential oils in the Far Eastern countries and he has collected useful information on the subject.

A short summary of the work done under the scheme has been described in this booklet. Agricultural, manufacturing and chemical aspects of the essential oil industry have been studied. Some details and schemes for the manufacture of essential oils have been worked

out. Several new perfume bearing plants e.g., peppermint, camphor, bearing ocimum, palmarosa and lemongrass have been successfully cultivated extensively in the fields at Kanpur. Improved stills and condensers have been designed and introduced in the Industry. Several essential oils, e.g. Kewda, Champa, Chameli, Juhi, Bela, Moulsari, Kadamb etc. have been prepared on semi large scale and chemically examined.

A large number of samples of vetiver oil distilled at chief producing centres in Northern India have been analysed with a view to draw up the specifications for North-Indian Vetiver Oils.

Attempts have also been made to import American variety of peppermint plants and Indonesian variety of vetiver plants.

Different varieties of rose flowers have been cultivated in the fields with a view to study their essential oil content and to find out the best variety of rose which would yield the maximum quantity of oil. The supply of some plants e.g., patchouli, lavendar etc. is being arranged from Bangalore and Ootacamund. Work on the preparation of aromatic chemicals and isolates has also been carried out.

The credit of this work goes to my colleauges and assistants, who have worked with me at H. B. Technological Institute. Mention may be made of Sarvsri G. N. Gupta, Ganesh Chandra, U. N. Shukla and K. N. Nautiyal. I also convey my thanks to Sri S. N. Ghatak for compiling some of the portions of the brochure and getting it published.

I am greatful to the Directorate of Industries, and the Government of Uttar Pradesh for financing the scheme for agricultural, manufacturing and chemical studies of the various problems connected with the subject.

I am also deeply indebted to the authorities of the Scientific Research Committee, U. P., and Essential Oils Research Committee, of the Council of Scientific and Industrial Research, New Delhi for placing adequate amounts of money at my disposal to carry out some of the work.

In the end, I thank Sri M. G. Shome and other officers of the Government Press, Lucknow, without whose help it would not have been possible to get the Brochure published in such a short time.

D. R. DHINGRA,
Controller of the essential Oil Scheme,
and
Principal, H. B. Technological Institute,
Kanpur.

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Development of Essential Oil Industry in Uttar Pradesh

Essential Oils and their composition:

Essential oils may be defined as odoriferous bodies of an oily nature and of vegetable origin. They are usually liquids at ordinary temperatures; although sometimes solids or semisolids and noramlly volatilise without decomposition.

The essential oils may occur in any part of the plants *viz.*, root, stem, bark, leaf, flower, seed, fruit or fruit shell. In some plants such as members of Coniferae, the essential oil may be present in all parts of the plant but usually the oil is restricted to only certain parts.

Essential oils differ from vegetable or fatty oils in their chemical composition; though both of them are derived from the vegetable kingdom. They are composed of terpenes, alcohols, aldehydes, ketones, esters, ethers, phenols, acids, nitrogenous and sulphur comopnds, while vegetable oils are the glycerides of higher fatty acids.

Uses:

Edward Sagarin has remarked—

"From dawn until twilight and long into night and from the cradle of the infant to the silence of the grave, we are surrounded by the odourous materials. Perfumes in one form or the other are a part of the things we see, touch, eat, wear and smell. We take our odours for granted and little realise how much we would be affected, if our lives are deprived of perfumes."

The applications of essential oils are very extensive and cover a wide range of human activities. A few important uses, to which they can be put to are in the manufacture of soaps, cosmetics, perfumes, medicines, confectionary, perfumed tobacco, aerated waters, syrups, disinfectants, detergents etc. Citral an isolate of lemongrass oil has recently been employed for the preparation of vitamin A.

Historical Survey:

The art of perfumery is of extreme antiquity. The essential oils and perfumes have been used since time immemorial and played and important part in ritual ceremonies.

The idea of essential oils and perfumes was first conceived and technically employed in the East, especially in China, Egypt, Persia and India, where expression, maceration and digestion and then gradually distillation of the woods, plants and flowers to produce essential oils was practised. The fumes of frankincense and myrrh giving light odours were employed in religious ceremonies and sacrifices and later on balsams, pomades and cosmetics began to serve the needs of mankind for the maintenance of the beauty of mankind.

Progress in the creation of natural perfume industry was made slowly. The first manipulation of perfumes was as therapeutic remedies utilizing immediate resources of nature, then as time passed on and the experience of mankind accumulated, they became the basis of secular employment of incense. The latter established the art of perfumery.

The Chinese are believed to be the forerunners in this art, but little is known about thier history. The first evidence of the use of perfumes in China dates back to a little before the first thousand years B. C.

From the monuments of Egypt (Preserved dead bodies of Egyptian rulers) it is evident that the Egyptians knew the processes for the preparation of oils, balsams and fermented liquors.

The Persians were probably the first to distil roses. According to Ibn Khaldun about 810–817 A. D., the province of Faristan (Persia) used to send 30,000 bottles of rose water to the treasury at Baghdad annually as a tribute.

An extensive trade in odoriferous oils and ointments was carried on between the ancient countries of the Orient, Greece and Rome.

In India references are available in Sutras and Vedas about the use of perfumes in ritual functions. The Indians were also familiar with the preparation of sacrificial liquors. The Buddhists used to wash the statues of Gods with perfumed waters. Kasturi (Musk), Chandan (Sandal wood), Kesher (Saffron) and Kapur (Camphor) have been used by the Indians since the Vedic period. In the Gupta period (300–400 A D.) the use of cream bases, facial cosmetics, hair oils, eye shadows etc., was common. A detailed historical account has been given by Dr. Sadgopal in the Indian Soap Journal 1948 and 1949. Mention is also made of Indian Perfumes in Pali and Islamic books. Moghul rulers were the great promoters of Indian perfumers. Abul Fazal in Aini-Akbari writes about Emperor Akbar "His Majesty is exceedingly fond of perfumes and the court chamber is continually scented with flowers and fumigated with preparations of ambergris and aloes, etc., which are burnt in gold and silver censers. His Majesty constantly perfumes his body and hairs with odoriferous ointments etc".

It is said that the Empress Noorjahan was in the habit of taking her bath in a tank full of rose water. She is also said to have first noticed the otto of rose floating on rose water on a cold morning in 1612 A. D.

Queen Elizabeth is reported to have used Indian perfumes. It may thus be seen that India had been a famous centre for the production of perfumes and allied products for consumption as well as for export to other countries. Kannauj, Jaunpur and Ghazipur all in Uttar Pradesh were the reputed centres of manufacture.

Unfortunately, the flourishing position which India had attained in olden times and medieval period dwindled down due to the lack of scientific knowledge and the inability of Indian manufacturers to adopt themselves to

modern scientific advancements and equipments with the result that the essential oil Industry in India is in a deplorable condition. The introduction of cheap aromatic chemicals and synthetic perfumes having odours almost similar to natural essential oils further decreased Indian exports. The application of cheap synthetic perfumes in the manufacture of soaps, cosmetics and confectionary, etc., induced Indian perfumers to import them in large quantities. Moreover, the development of essential oil-bearing plants in other tropical countries under their Governments' patronage took away from India the monopoly enjoyed by her in ancient times. The old fashioned equipments and methods of production could not compete the modern scientific equipments and processes backed by mechanised agriculture and mass production etc. Therefore, improvements in the existing equipment and processes are to be introduced early to develop the present state of essential oil industry in the country.

Statistics of essential oils:

No exact statistical data are available regarding the production of essential oils in India. The approixmate quantities of different oils manufactured in the country are given below:

TABLE NO. 1

		Tons.
1.	Sandal wood oil	100
2.	Lemongrass oil	750
3.	Palmarosa oil	85
4.	Gingergrass oil	3
5.	Eucalyptus oil	10
6.	Vetiver oil	2
7.	Linaloe oil	3
8.	Geranium oil	1
9.	Cinnamon leaf oil	2
10.	Ajowain oil	1
11.	Citrus oils	300 Lbs.

Besides attars and perfumed waters, small quantities of other oils e.g., dill, fennel, rose etc. are also produced in the country. India exports sandalwood oil, lemongrass oil and palmarosa oil in huge quantities to foreign countries.

TABLE NO. 2

Export of essential oils (Value in Rupees).

	1949-50	1950-51	1951-52	1952-53	1953-54
1. Lemongrass oil ..	46,62,336	1,32,64,366	1,49,00,224	39,17,100	53,88,096
2. Sandalwood oil ..	43,89,579	73,31,801	32,53,666	50,34,545	55,99,490
3. Palmarosa oil ..	23,88,279	39,49,263	27,17,280	20,83,608	13,07,041
4. Other sorts ..	1,33,308	4,65,100	1,97,852	2,11,801	2,42,640
Total	1,15,73,502	2,50,10,530	2,10,69,022	1,12,47,054	1,25,37,267

India also exports essential oil bearing seeds e.g., dill, fennel, cumin, coriander etc. in large quantities.

TABLE NO. 3

Export of essential oil bearing seeds (Value in Rupees).

Name of seeds	1949-50	1950-51	1951-52	1952-53	1953-54
1. Ajama	42,641	53,483	1,65,522	54,141	50,191
2. Ajowain ..	77,829	1,37,099	2,61,755	1,78,428	67,046
3. Aniseed	31,418	67,964	2,29,322	62,356	32,122
4. Coriander.. ..	26,51,459	44,44,826	29,36,085	9,77,903	13,10,053
5. Cumin (black) ..	91,950	1,95,645	1,17,182	58,130	10,805
6. Cumin (other than black).	4,49,032	19,30,406	48,56,466	21,00,542	4,53,696
7. Fennel	14,60,720	14,26,606	22,15,062	15,64,221	16,94,947
8. Fenugreek ..	5,67,806	5,84,126	8,18,690	5,52,903	5,21,691
9. Sowa (dill) ..	2,15,194	2,71,026	2,80,978	2,52,452	3,61,516
10. Other sorts ..	46,588	2,130	1,69,598	1,63,408	1,77,179
Total seeds	56,34,637	91,13,311	1,20,50,660	59,64,484	46,79,246

TABLE NO. 4

Export of spices

Spices	1949-50	1950-51	1951-52	1952-53	1953-54
1. Cardamom ..	1,25,18,513	1,47,60,675	1,64,15,710	1,63,73,327	1,34,33,232
2. Cinnamon ..	6,100	..	..	..	..
3. Cloves	12,262	..	..	..	..
4. Ginger	41,71,128	92,40,671	84,65,504	52,10,821	44,76,315
5. Pepper	14,50,46,135	20,40,32,811	23,22,27,311	15,95,91,125	12,71,65,137
6. Turmeric ..	1,10,22,088	1,25,83,161	1,00,26,032	46,69,855	64,90,694
Wood—					
Sandal	23,39,430	37,62,043	21,07,924	32,01,126	..

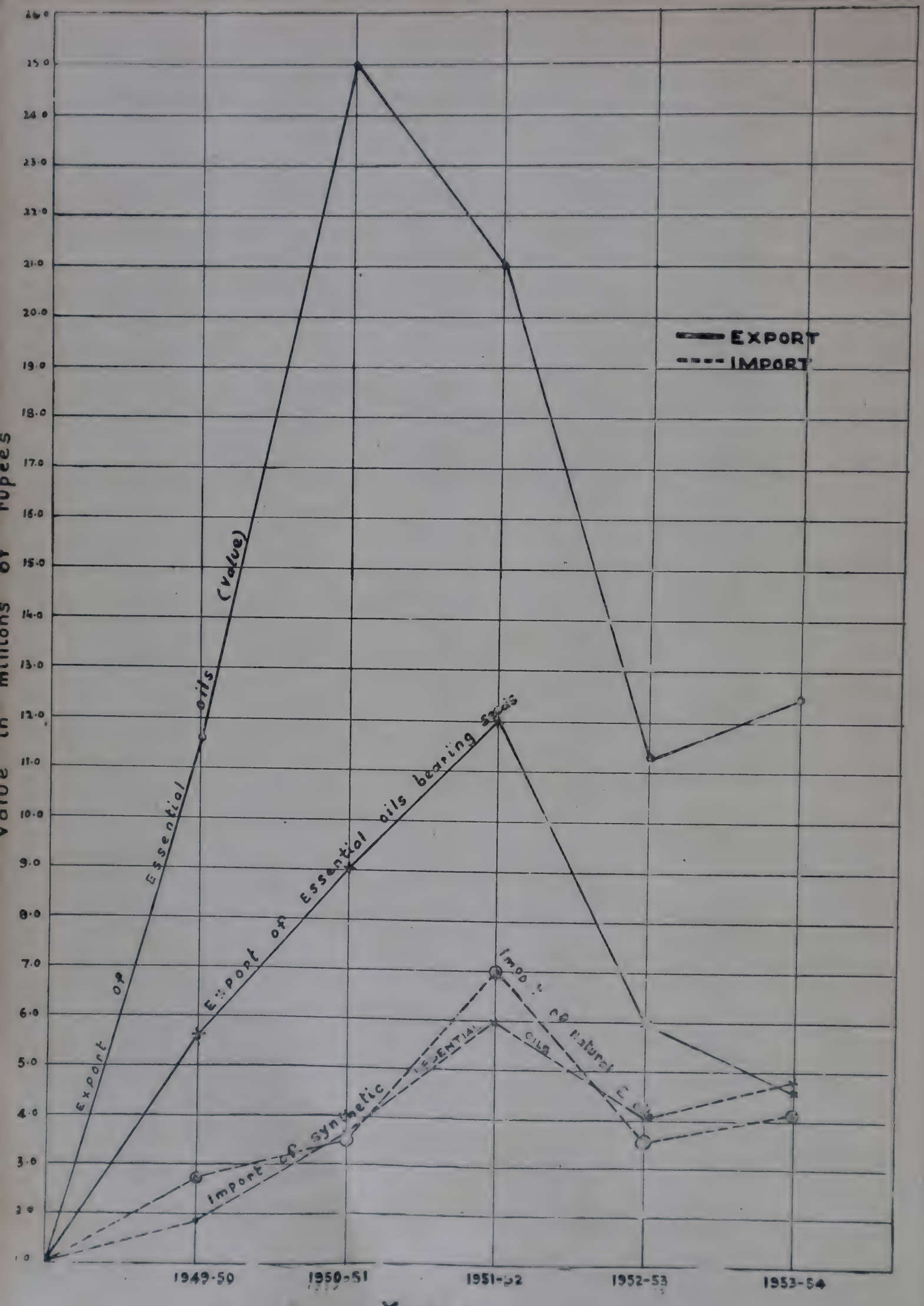
Value in millions of rupees
EXPORT
IMPORT
Export of Essential oils (value)
Export of Essential oils bearing seeds
Import of synthetic ESSENTIAL OILS
Import of natural E. Oils
1949-50
1950-51
1951-52
1952-53
1953-54
Years

Diagram A

The total value of essential oils, essential oil bearing seeds, spices and sandal wood that are exported from India is about Rupees Twenty crores per year. The total value of essential oils including attars, perfumed waters and hairs oils manufactured in the country would come upto Rs.4.5–5.0 crores approximately.

India imports natural essential oils e.g., peppermint, bergamot, lavender, camphor and citrus oils etc., which are not produced inthe country, together with synthetic essential oils. The table below gives the imports of essential oils.

TABLE No. 5

Imports of essential oils (Value in Rupees)

Oils	1949-50	1950-51	1951-52	1952-53	1953-54
Synthetic	18,39,400	36,91,200	59,36,700	41,78,400	47,23,443
Natural—					
1. Almond	1,200	600	9,100	2,900	..
2. Bergamot ..	75,900	1,71,200	1,41,700	1,13,200	1,89,822
3. Cajuput	13,200	21,900	15,600	8,300	8,298
4. Camphor	2,900	1,300	10,200	8,000	7,544
5. Cloves	1,32,300	1,42,100	1,90,500	91,300	1,46,302
6. Dill	1,500	1,700	..	200	40
7. Eucalyptus ..	60,700	42,900	16,700	1,000	..
8. Lavender ..	2,62,400	2,14,300	4,91,700	1,94,000	3,35,160
9. Lemon	1,70,600	2,00,900	3,05,100	1,29,000	1,70,373
10. Ottorose	8,000	16,400	10,200	3,700	1,27,839
11. Peppermint ..	3,75,900	5,36,700	6,14,000	3,25,900	3,78,348
12. Other sorts ..	16,38,000	22,41,100	51,63,100	26,77,200	28,33,069
Total ..	45,82,000	72,82,300	1,29,04,600	77,33,100	89,20,238

[Diagram "A"]

Besides the above natural and synthetic essential oils, India also imports sundry aromatic chemicals used in soaps and cosmetics, but their statistics are not available, because they are imported under several classes, e.g. chemicals, drugs and solvents etc. e.g. camphor is imported under drugs and its import is given below :

TABLE No. 6

Import of Camphor

Years	Quantity in lbs.	Value in rupees
1949-50	1,340,307	23,96,204
1950-51	1,359,230	29,52,688
1951-52	2,945,660	86,27,694
1952-53	498,913	11,22,890
1953-54	925,678	14,92,951

Methods of manufacture :

The following methods are adoped for the manufacture of essential oils :

1. Distillation.
   (*a*) Water distillation,
   (*b*) Water and Steam distillation,
   (*c*) Steam Distillation.
2. Expression.
3. Extraction by means of solvents.
   (*a*) Without the use of heat, better known as enfleurage.
   (*b*) With the aid of heat—called maceration.
   (*c*) Using volatile solvents e.g. petroleum ether, benzene etc.

Distillation :

This a very old process, from which has been evolved the distilling apparatus of modern times. Essential oils are highly volatile and are easily carried away by steam without undergoing decomposition. Different distillation processes mentioned above are employed depending on the nature of product and the yield. The following precautions should be taken in distillation :

(1) Maintenance of as low a temperature as possible, because practically all the constituents of essential oils are some-what unstable at high temperatures.

(2) The presence of water is essential with the plant material as it increases the rate of removal of essential oil by distillation. Therefore in case of steam distillation, some water should be kept to promote diffusion.

(3) The raw material should be fed in proper condition for distillation. Very fine powder should not be used in distillation since it is apt to form an impenetrable mass to the outgoing vapours or steam, consequently a portion of the charge remains untreated.

(4) Since the constituents of essential oils, with a few exception, are soluble in hot water to atleast a slight degree, therefore, the large amounts of water present with the raw material will decrease the yield of oil. This factor is of considerable importance in water distillation.

(5) As essential oils contain esters to a certain extent, the presence of water especially at higher temperatures tends to hydrolyse them into acids and alcohols resulting in lower yield of oil. The greater the amount of water, the greater is the hydrolysis. Hydrolysis is greatest in water distillation and least in steam distillation method. Therefore to avoid hydrolysis the distillation should be completed as early as possible.

(6) In case of flowers, they have a tendency to agglutinate under the influence of steam and form large lumps. Therefore, steam distillation is not recommended for flowers. For small installations, particularly in portable units, water distillation or water and steam distillation method are quite suitable. The latter is rapidly superseding the former, because of better quality and higher yield of oil and rate of evaporation. For large scale work, steam distillation is undoubtedly the best method as it gives better yield and quality of oil and the temperature in distillation can also easily be controlled.

Condition of raw materials :

The materials should be in such a condition that water or steam may completely permeate the mass and carry over with it every particle of essential oil present in it. In many cases such as flowers, leaves, grasses or other non-fibrous parts of plants, the raw materials require no treatment but in case of hardwood, seeds, fruits roots and barks etc. disintegration or crushing may be necessary in order to rupture as many cell walls as possible to render the oil easily accessible to steam. The material after crushing should be distilled immediately, otherwise essential oil will partly evaporate. As already stated fine powder should not be used for distillation. Orris root, patchouli leaves and vanilla beans require sometime to develop their fragrance.

Some materials benefit by drying or storage. In case of geranium and ocimum kilimandscharicum, the yield of oil increases in dry storage . Flowers, leaves and herbs etc., with high water content lose much of their essential oil by air drying. The loss is caused by evaporation, oxidation, resinification and other chemical actions. They should, therefore, be distilled, within a few hours of their gathering, otherwise fermentation will set in. For storage of plant materials air conditioned houses should be employed, which are kept dry at lower temperatures. Extreme variations in moisture content of atmosphere and exposure to air favour oil evaporation, resinification and partly oxidation.

Water distillation method :

This process is simple, requires less investment and is widely used throughout the world. Essential oils in India are in general made by this process.

In this method, the material is in contact with a large amount of boiling water. It may either float or remain completely immersed leaving sufficient space for vapour. The still is heated by direct fire. With careful working, the quality and yield of oil are satisfactory, but if a part of the material comes in contact with hot sides of the still, destructive distillation takes place giving rise to obnoxious bodies, which impair the odour of the oil. This defect can, however, be overcome by using stills provided with false bottom. The materials which agglutinate in contact with steam can easily be processed by this method. The process is not economical, as the plant material is not completely exhausted and it requires more fuel and labour etc. Further high-boiling and water soluble oil constituents are not completely vapourised and remain dissolved in water. It has a slow turnover, because after each distillation, the still is to be cleaned and fed again. Thus time is wasted in these operations. In this process, a round or flat bottomed still having large surface for heating with some condensing arrangement for vapour is needed.

The rate of distillation and the yield of oil are low and hydrolysis is much more than in other processes.

As oil and water evaporate, part of the charge will soon cease to be covered with water and hence it would be protected no longer form over-heating. It is advisable, therefore, to add more water as the distillation proceeds. Moreover, the charge above the water level tends to form lump together and becomes almost impenetrable for steam. Therefore, the still should be filled with water such that at the end of operation, the charge remains fully immersed in water. This process is suitable for finely divided materials, herb and grasses.

The rate of distillation should be maintained at the maximum in order to obtain the highest quantity of oil, because, by rapid distillation, the charge, remains in loose condition to ensure thorough penetration of the plant material by rising steam.

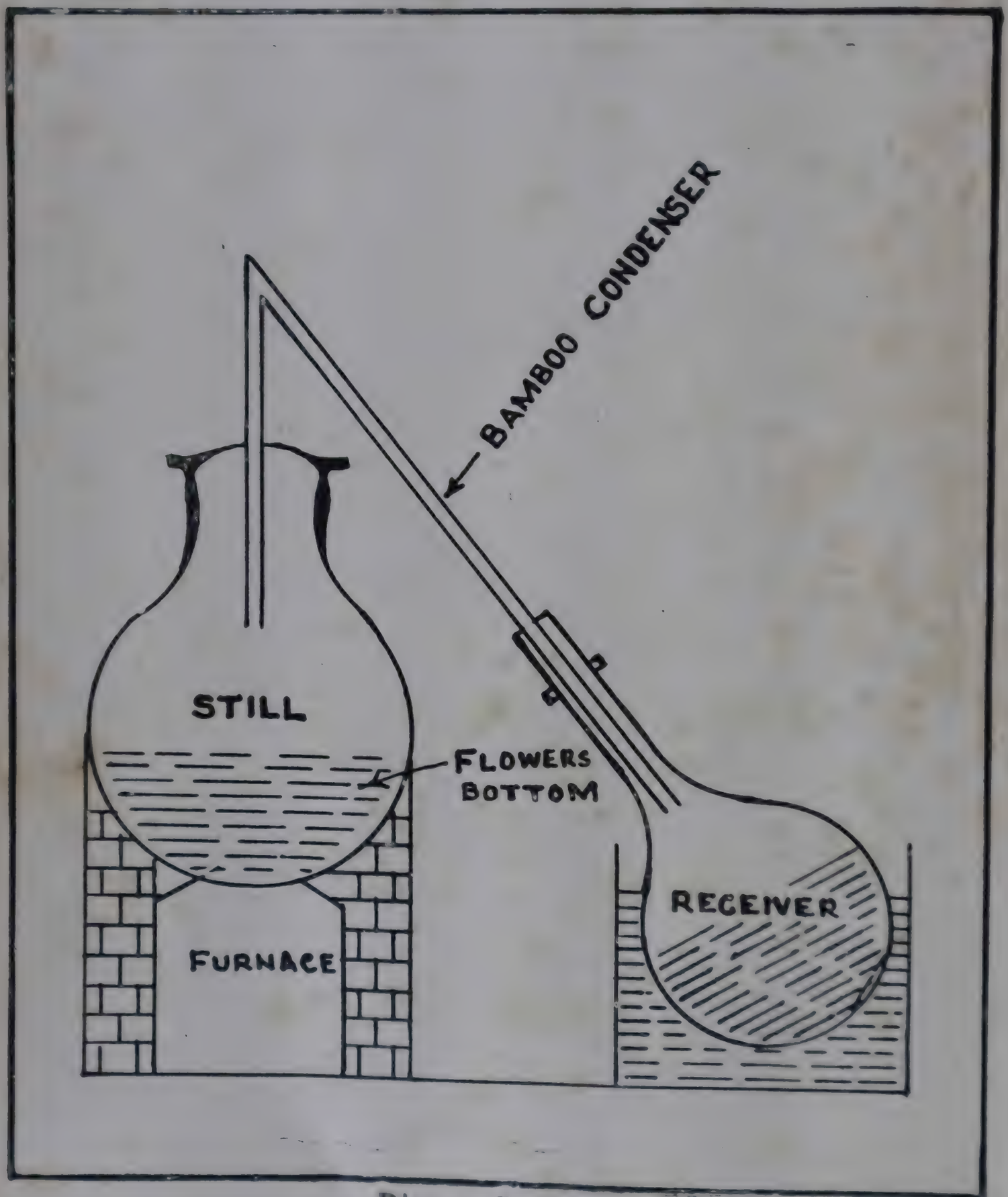

Diagram B

PHOTOGRAPH NO. 2

Steam distillation equipment

In India a still with a round bottom called "deg" is used. It is covered at the top with a cover called "sarposh" with a hole at one side through which a bamboo condenser called "chonga" passes. The distillate is collected in a receiver called "bhapka". A rough sketch of the equipment is given below :

[Diagram B.]

Water and steam distillation :

The method has become more popular among small producers. The smaller units are heated by direct fire and larger ones by steam jacket or closed steam coil. In this process the charge is kept over a false bottom and out of contact with boiling water. The charge is distilled with saturated low pressure steam. The plant materials should neither be finely ground nor contain long stalks and bigger pieces of roots or barks etc.

If a charge tends to agglomerate when wet, it is advisable to add small pieces of absolutely netural material to keep the charge porous. It gives less rise to products of decomposition in the oil by hydrolysis, polymerisation or resinification. It requires less fuel and less time for distillation but yields more oil.

As much steam condenses in the plant material, the latter agglutinates and yields oil very slowly. Oils of high boiling points require long hours of distillation. The water beneath the perforated grid is discarded after the distillation is over and replaced with fresh water. It is necessary because soluble matter from the plant materials collect in the water and its repeated use may cause the decomposition of the water soluble matter causing disagreeable odours. This method is not in general use of perfumers in India.

Steam distillation :

In this method, steam usually of pressures higher than atmospheric one is injected into the still. During distillation the temperature of the charge will rise to the temperature of steam and not to the temperature of boiling water. The superheated steam has the tendency to dry out the charge and reduce the rate of recovery of essential oil. High pressure steam causes considerable decomposition.

This process excels water distillation and water and steam distillation methods as regards cost, rate of distillation, capacity of production and quality of the oil distilled. In particular cases, where the high temperature of steam destroys the perfume, the amount of oil is relatively small or it is readily soluble in water. Flowers and fine powders are not in general suited to steam distillation.

In India this process is used chiefly for the manufacture of turpentine and sandal-wood oils. Khas oil has recently been prepared by two firms in U. P. by steam distillation. The general equipment employed is given below :

"Photograph No. 2"

Expression :

This method is utilized for the extraction of essential oils from the peels of citrus plants *viz.*, oranges, lemons, and bergamot etc. The oils extracted by distilling the peels lack the freshness of aroma.

There are 3 main processes :

(1) Sponge process,
(2) Ecuelle method,
(3) Machine process depending on the above methods.

The Sponge Process :

It is an old method, in which the fruit is cut across the shorter axis and the kernel removed by spoon. The peel is then either moistened or steeped in water to facilitate the removal of oil. The peels are then pressed between the spongs by hand and the drained oil is collected and filtered. The quality of oil produced is very good. The method is now going out of use owing to its low yield.

Sfumatrice :

Mechanical machines have been developed in place of sponge method. They are classified under the general name "sfumatrice". In these machines, the peels are subjected to considerable pressure. The yield of oil is also higher and the quality is as good as that by sponge method.

The Ecuelle Method :

It consists of a hollow metallic funnel with spikes, the fruits are rolled on these spikes. The oil cells are punctured and the liquor flows to the bottom The oil is decanted and centrifuged. The Ecuelle process is even less satisfactory than the sponge method and is no longer used. Various types of machines have been developed in Italy and U. S. A. based on this principle.

Rasping machines :

These machines are based on Ecuelle principle. They consist of two channels between which the fruit is rolled. The skin is lacerated by means of spikes. The mixture of the oil and juice is collected and subsequently separated and clarified.

The most modern and efficient method consists in crushing the whole fruit in a mill between two pairs of rollers placed vertically one below the other. In this process, the oil bearing cells of the peels are all broken and the oil liberated is mixed up with the juice. The mixture is centrifuged to remove the oil.

Extraction by solvents :

It has already been pointed out that by means of distillation, essential oils of high purity and very fine aroma can be obtained. In a large number of cases, however, this method does not produce satisfactory oils because many unstable aromatic substances are destroyed by the high temperature of the steam, while in other cases, the quantity of essential oil that could be obtained is very small. In view of these facts solvent extraction method is used. The materials used may be volatile or non-volatile, the latter are again sub-divided according to conditions of temperature during the process.

PHOTOGRAPH NO. 3

Influerage process for the manufacture of Essential oil

PHOTOGRAPH NO. 4

Manokamini Flowers

PHOTOGRAPH NO. 5

Tube rose Flower

PHOTOGRAPH NO. 6

Citrus Veticulata (*Narangi*)

Extractions by means of non-volatitle solvents :

(*a*) At normal temperature—Enfleurage. Photograph No. 3.

(*b*) With the application of heat—Maceration.

(*a*) *Enfleurage*—This is applied mainly to jasmine, tuberose and sometimes to orange blossom, jonquil, muguet, etc. In this process a thin layer of purified fat is applied on both sides of glass plates supported on wooden frames called "chassis", a margin being left near the edges. The flowers are spread lightly on the fat and the absorption surface is increased by making grooves in the fat layer by a wooden spatula. Several chassis, thus prepared are placed one above the other, so that the flowers are enclosed between two layers of the fat, (the upper and the lower) which absorbs the perfume as it is given off. The exhausted flowers are removed daily in case of jasmine and after every two or three days in case of tuberrose. The chassis are turned over often so that an even distribution of the perfume results. The renewal of the flowers continues until the fat is fully saturated. The resulting fat is known as "pomade". The pomade is treated with 95 per cent. alcohol, cooled and filtered. The filtrate is distilled leaving behind the absolute.

The fats most commonly used are lard or beef suet or a mixture of these two. The yield of absolute obtained is much higher than the oil by other processes.

(*b*) *Maceration*—It consists in immersing the flowers in liquid fats or oils at a temperature of about 60—70 degrees C. Cassie, rose, orange blossom and violet flowers are generally treated by this process. The flowers are mixed with hot greases or oils in pans and the whole content stirred for a known period. The cells containing the essential oil are ruptured by heat and the aromatic constituents are absorbed by the fat. The contents of the pan are filtered and further quantities of fresh flowers are mixed with it. The process is repeated until the extraction *media*, i.e., fat becomes fully saturated with perfume. The absolute or oil is recovered from the fat by treatment with alcohol as given under enfleurage.

Extraction with volatile solvents :

This is the most common practice these days. Several solvents such as chloroform, benzene, methyl and ethyl alcohols, acetone and petroleum, ether, etc., may be used. Out of which petroleum, ether and benzene are generally used. The solvents are purified by treatemnt with sulphuric acid. The extraction is carried out in extractors, which are either stationary or mobile and cylindrical in shape fitted with false bottoms over which the raw materials are placed. They are hermetically sealed and interconnected through tubes. The solvent comes in direct contact of the material and runs slowly from one extractor to the other, until the flowers are exhausted. The product left behind in the distillation still after distilling the solvent is solid or nearly so and is known as "concrete". In order to remove plant waxes from the concrete the latter is treated with alcohol, the

mixture is cooled and filtered to remove solidified waxes. The filtrate is then distilled to recover the absolute.

In a number of cases, the absolute from flowers contain varying amounts of colouring matter, depending on the volatile solvent used for extracting the flowers. These pigments can be removed either by distillation in presence of a neutral and odourless wax or by exposure to ultraviolet rays.

Water distillation process is most commonly employed in the country on cottage scale.

Itr or Attar:

It is an indigenous product of India and is prepared by distilling the flowers and absorbing the perfumed vapours in sandal wood oil. The quality of attar depends on the quantity of flowers used in a known quantity of sandal wood oil. Cheaper quality of attars are made by using liquid paraffin instead of sandal wood oil.

Perfumed Hair Oils :

They are made by a modified enfleurage process. The process consists in spreading flowers of chameli, juhi, bela or rose flowers over washed til seeds in alternate layer, so that the perfume is absorbed by them. The exhausted flowers are removed the next day and fresh flowers are put in. This process is repeated several times, till the seeds are saturated with the perfume. The seeds are then crushed in a ghani producing perfumed Hair Oil. The quality of the oil depends on the quantity of flowers used in different batches.

Perfumed Waters :

Such waters are used for scenting water at ceremonial functions and also in confectionary and toilets. Some waters or aquas called "Araks" are employed in Ayurvedic medicines such as aqua dill, aqua aniseed, etc. Two types of waters prepared from rose and kewda flowers are mostly used in perfumery. The rose water is designated on the quantity of flowers used in the distillation, while kewra water by the number of flowers in the charge. If 5 gallons of distillate is collected by distilling 1 maund of rose flowers, it is called rose-water from one maund or "Ek mana" Rose-water. Similarly by distilling 2 maunds of rose flowers if 5 gallons distillate is collected, it is called rose-water from 2 maunds or "Domana" or so on.

In case of kewda flowers, if 5 gallons of distillate is collected by distilling 1,000 flowers, it is called kewda-water from one thousand flowers or "Ek Hazara". Similarly kewda-water prepared from two thousand flowers will be called "Dohazara" and so on.

Manufacture of essential oils in India :

The essential oils are manufactured in Madras, Bombay, Mysore, Hyderabad, Madhya Pradesh, Uttar Pradesh, Rajasthan, Orissa Travancore and Chochin, etc. Nearly all the lemongrass oil is made in Travancore and Cochin, palmarosa oil in Khandesh, Hyderabad and Madhya

and Madhya Pradesh, sandal wood oil in Mysore, Kannauj and Fyzabad (Uttar Pradesh), Eucalyptus and Cinnamon oils in Madras, Linaloe oil in Mysore, Vetiver or Khas oil in Rajasthan (Bharatpur), U. P., Malabar and South Travancore and Orange oil in Madhya Pradesh. Attars are made in Ghazipur, Jaunpur, Kannauj and Aligarh all being in Uttar Pradesh. Ganjam (South Orissa) is famous for Kewda flowers and Perla-Kimadi (Orissa) for Champa flowers. The attars of these flowers are made there.

As already indicated above the total value of essential oils and attas produced in India amounts to 4.5 to 5.0 crores approximately per annum, out of which U. P., alone contributes to the extent of about 1.5 crores per annum. The State of Uttar Pradesh has always been a pioneer in this cottage industry.

In Uttar Pradesh there are four sandal wood oil factories and two khas oil factories. There are about 500 perfumers (big and small) which manufacture oils, attars, hair oils and perfumed waters, etc., on cottage scale.

The number of persons employed in their manufacture and sale is about 30,000 (seasonal) and 5,000 all the year round. These figures do not include the number of farmers and other personnel, who are engaged in the supply of the raw materials. In the State, about 25,000 maunds of rose flowers, 400 maunds of bela flowers, 1,800 maunds of chameli flowers and small quantities of juhi, Harsinghar, kewda, and moulsari and Kadamb flowers, etc., are consumed annually.

As the essential oil trade has mainly been handled by our State perfumers, therefore, the imporvements in the methods of distillation and equipments in the State would really develop the existing industry of the country.

With a view to develop the essential oil industry in the State the Government of Uttar Pradesh sanctioned the Essential Oil Scheme in 1948-49. The main aims and objects are :

Aims and Objects :

(1) To improve the existing methods of distillation and also the equipment used for distillation.

(2) To cultivate new perfume bearing plants in the State.

(3) To study the effect of various types of manures on the yield of flowers and crops.

(4) To prepare Ottos or absolutes of the popular flowers not so far made in India.

(5) To analyse the essential oils with a view to assist in drawing up their specifications for export and home consumption.

(6) To prepare synthetic aromatic chemicals from the raw materials available in the country.

(7) To train students and persons from the industry in the art of manufacture of essential oils.

The work of the scheme was taken up at H. B. Technological Institute, Kanpur, since the very inception of the scheme and is still being carried out there.

Achievements:

The work can be devided under the four following heads :

(1) Survey of areas under cultivation of different perfume bearing plants including khas roots.

(2) Cultivation of perfume bearing plants—

(i) the effect of various fertilizers and manures on the yield.

(ii) to study the conditions for the cultivation of new plants not so far grown in the State.

(3) Research work in the Laboratory and outside.

(*a*) To devise improvements in the existing methods of manufacture and equipments used for essential oils.

(*b*) Determination of the oil content of various materials and also at different centres.

(*c*) Examination of essential oils thus obtained with a view to fix up standards for those oils.

(*d*) Preparation of synthetic essential oils and aromatic chemicals.

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1. SURVEY OF AREAS UNDER CULTIVATION OF DIFFERENT PERFUME BEARING FLOWERS INCLUDING KHAS (VETIVER) ROOTS

A survey of the areas under cultivation of different perfume bearing flowers in the State has been carried out. The table below gives the areas together with the yield of flowers per acre.

TABLE No. 7

1. Rose Flowers :

Particulars	Farrukh-abad	Aligarh	Ghazipur	Kanpur	Ballia	Jaunpur	Season
Acreage ..	342	963	7.0	76.0	..	..	
Maximum yield/ acre.	10 mds.	21 mds.	4 mds.	..	..	..	March-April.
Average yield/ acre.	8 „	15 „	3 „	..	15 mds	..	
Total yield ..	2,736 „	14,445 „	21 „	..	705 „	..	

Bela Flowers—

Particulars	Farrukh-abad	Aligarh	Ghaizpur	Kanpur	Ballia	Jaunpur	Season
1. Acreage ..	38	..	4	..	10	4	
2. Max. yield/acre.	12 mds.	..	5 mds	..	12 mds.	14 mds.	April to August, Maximum in May and June.
3. Average yield/acre.	10 „	..	4 „	..	10 „	12 „	
4. Total yield	380 „	..	16 „	..	100 „	48 „	

Chameli Flowers—

1. Acreage ..	82	..	165	..	37	44	
2. Max. yield/acre.	12 mds.	..	5 mds.	..	14 mds.	8 mds.	August to October.
3. Average yield/acre.	9 „	..	4 „	..	12 „	6 „	
4. Total yield	738 „	..	660 „	..	444 „	264 „	

Juhi Flowers—

1. Acreage ..	1	..	10	..	..	1.5	
2. Maximum yield/acre.	1 ¼ mds.	..	2 mds.	..	..	3 mds.	July-August.
3. Average yield/acre.	1 „	..	1 „	..	..	2 „	
4. Total yield	1 „	..	16 „	..	..	3 „	

Kewda Flowers—

Particulars	Badaun	Ghazipur	Ballia	Season
1. Acreage	No regular cultivation.	2	6	
2. Average yield/acre		1,500	1,500	July.
3. Total yield	6,000 flowers.	3,000 flowers.	9.000 flowers.	

Khas (vetiver) roots—

Khas roots grow wild and are not cultivated anywhere except to a small extent in Travancore-Cochin and Malabar Hills. The areas under khas in Uttar Pradesh and Bharatpur have been surveyed and an approximate quantity of khas roots available from each centres is given below :

Musanagar—It is situated in Kanpur district. The main places famous for Khas are Fatehpur, Milkanpurwa, Turkman, Ghai, Ghaguwa, Shrinagar, Makhauli, Unchhar and Kachha. About 2,000—3,000 maunds of khas roots are distilled annually by parties from Kannauj and other places.

Jahanabad—It is near Musanagar, but in the district of Fatehpur. Kaitha, Shoolpur, Bahora, Shivpur and Patora, are other centres of distillation where about 2,000 maunds of khas roots are distilled annually.

Math—Surir, Seharia, etc., are the centres of distillation in Mathura district. Khas is found on the banks of Jamuna river. About 2,000 maunds of roots are distilled every year.

Biswan—Patini and Sanda are the centres of distillation in Sitapur district. About 4,000 maunds of roots are distilled every year.

Kaurialaghat—It is near Lakhimpur Kheri. There is some scarcity of labour in this area. About 1,000 maunds of roots are distilled per year.

Pilibhit—Bhira, Sultanpur, Puranpur and Mala are the distillation centres. About 2,000 maunds of roots are distilled and nearly 4,000 maunds of roots are dug out per year, for making khas tattis, etc., by contractors.

There are other small centres in the district of Hardoi, Etawah, Gonda, Shahjahanpur, etc. In total nearly 30,000 maunds khas roots are distilled in U. P., alone.

Bharatpur—It is the biggest area in Northern India. Kumher, Bharatpur and Rupwas tahsils are famous for khas roots. 8,000—10,000 maunds of khas roots are annually distilled. Kharika, Bhot, Fatehpur, Akta Kherara, Badpipal, Thai, Saugar Taria, and Malaka are the centres of distillation in Bharatpur.

Dholpur—Bari, a town in Dholpur district is famous for khas roots. Nearly 3,000—4,000 maunds of khas roots are annually distilled there.

South India—The total quantity of khas roots extracted in South India, i.e., Malabar and Travancore Cochin as estimated by Menon and Ittyachan, is 15,000 maunds annually. At present about 5,000 maunds are annually distilled there.

In Punjab 10,000 maunds of roots are extracted annually for matting preparations. Only a little quantity is used for making khas oil.

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2. CULTIVATION OF PERFUME BEARING PLANTS TO STUDY THE EFFECT OF VARIOUS FERTILIZERS AND MANURES, THEIR YIELD PER ACRE AND TO STUDY THE CONDITIONS OF CULTIVATION OF NEW PERFUME BEARING PLANTS NOT SO FAR GROWN IN THE STATE

Cultivation of flowers, e.g., rose, bela, chameli, etc., has been done on two plots in order to study the effect of farm yard manure and artificial manures either alone or in combination on the yield of flowers per acre.

The table below gives the results of experiments conducted on rose flowers :

TABLE No. 8

	Manure	Yield per acre
1.	Farm yard manure	31.0 Mds.
2.	Potassium Nitrate or Nitre	36.5 „
3.	Ammonium Sulphate	43.0 „
4.	Ammonium Sulphate and Farm yard manure	38.5 „
5.	Ammonium Sulphate and Nitre	41.0 „
6.	Super phosphate	28.5 „

It may be observed that the maximum yield of 43 maunds/acre was obtained by using ammonium sulphate as a manure.

Several new perfume bearing plants which have not so far been cultivated, e.g., peppermint, lemongrass, palmarosa, etc., have been successfully planted.

(a) Grasses—Peppermint and camphor bearing ocimum received from Forest Research Institute, Dehra Dun, Palmarosa seeds from the Chief Conservator of Forest,s Madhya Pradesh, have been planted in the gardens of H. B. Technological Institute. The table below gives the average yield of the leaves per acre and the percentage yield of oil from them. The optimum conditions for their cultivation have also been determined :

TABLE No. 9

	Particulars	Yield of fresh leaves/ acre per year	No. of cuttings per year	% yield of oil
1.	Peppermint	150—200 mds.	2	0.2—0.25% on fresh leaves.
2.	Camphor bearing Ocimum	25—30 mds. (dry leaves).	3	3.0—3.4 % on dry leaves.
3.	Palmarosa (*Motia*) ..	150—200 mds.	2	0.15—0.17 % on fresh leaves.
4.	Ginger grass (*Sofia*) ..	150—200 mds.	2	0.1—0.12 % on fresh leaves.
5.	Lemon grass	150—180 mds.	4	0.14—0.22 % on fresh leaves.

(*b*) *Flowers*—Some flower plants, *viz.*, Tuberose, champa, manokamini, narcissus, roseteplitz, etc., have also been grown in the fields to study their yields and also the oil contents.

[Photographs No. 4 and No. 5.]

Khas plants received from Bharatpur, Tranvancore, Kaurialaghat, etc., have been cultivated in the fields. The plants are still immature.

3. RESEARCH WORK IN THE LABORATORY AND OUTSIDE

(a) Improvements in the existing methods and equipments used for the manufacture of essential oils—The essential oils are generally made by distilling the raw materials, collecting the distillate and separating the oil floating on the surface. This practice is not applicable in those cases where the percentage yield of oil is very low or when the various constituents of the oil are soluble in water. Under such circumstances, the essential oil is recovered by extracting the distillate with the purified solvents e.g., benzene, petroleum, ether, etc. The solvent layer is separated and distilled. The last traces of the solvent are removed under vaccum. The residue left behind is the essential oil or the otto. Using this method, the otto of kewda, bela, champa, juhi. kadamb, etc., have been prepared.

In the country stills used by the perfumers of the State for the manufacture of attars, essential oils and perfumed waters, there is always a danger of the plant material being overheated and thus to deteriorate the quality of the products. Secondly the arrangement for condensing the perfumed vapours is very poor and there is always some loss due to this leakage.

An improved type of still with a false bottom has been designed in order to avoid overheating and carbonization of the raw materials resulting in the production of better quality of oils.

[Diagram C.]

For condensing the vapours efficiently and to reduce the loss of oil, double surface and tabular condensers have been designed. A special box type condenser has also been designed for the condensation of camphor and camphor oil. The blue prints of the condensers are given below :

[Diagram D.]

A special type of distillation still has been designed for the manufacture of vetiver oil. A firm in Kanpur has installed similar type of still for the distillation of khas oil. The yield of oil obtained is about 25 per cent. more than by using country stills.

(b) Determination of the oil content of various materials and also at different centres—Experiments have been carried out to determine the percentage yield of oil from Rose flowers grown at Aligarh, Ghazipur and Kanpur and also of different varieties of roses, i.e., Rose Edward and Rosa Damascena. etc. Similar experiments have also been conducted on kewda, chameli and bela flowers as well. The table below gives the results of the experiments :

An Improved type of still for distillation of Essential oils.

(Designed at H.B.T.I.)

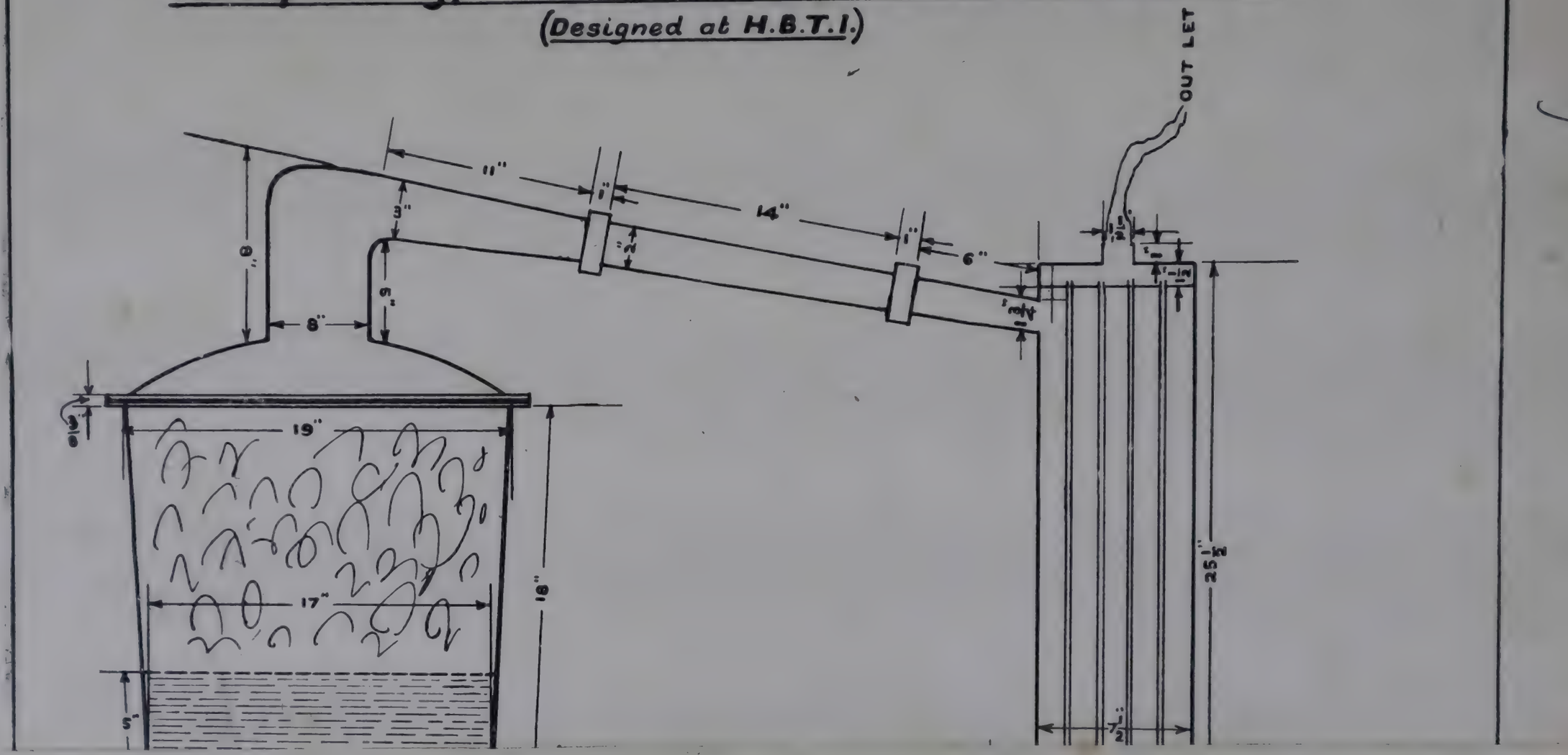


Diagram D

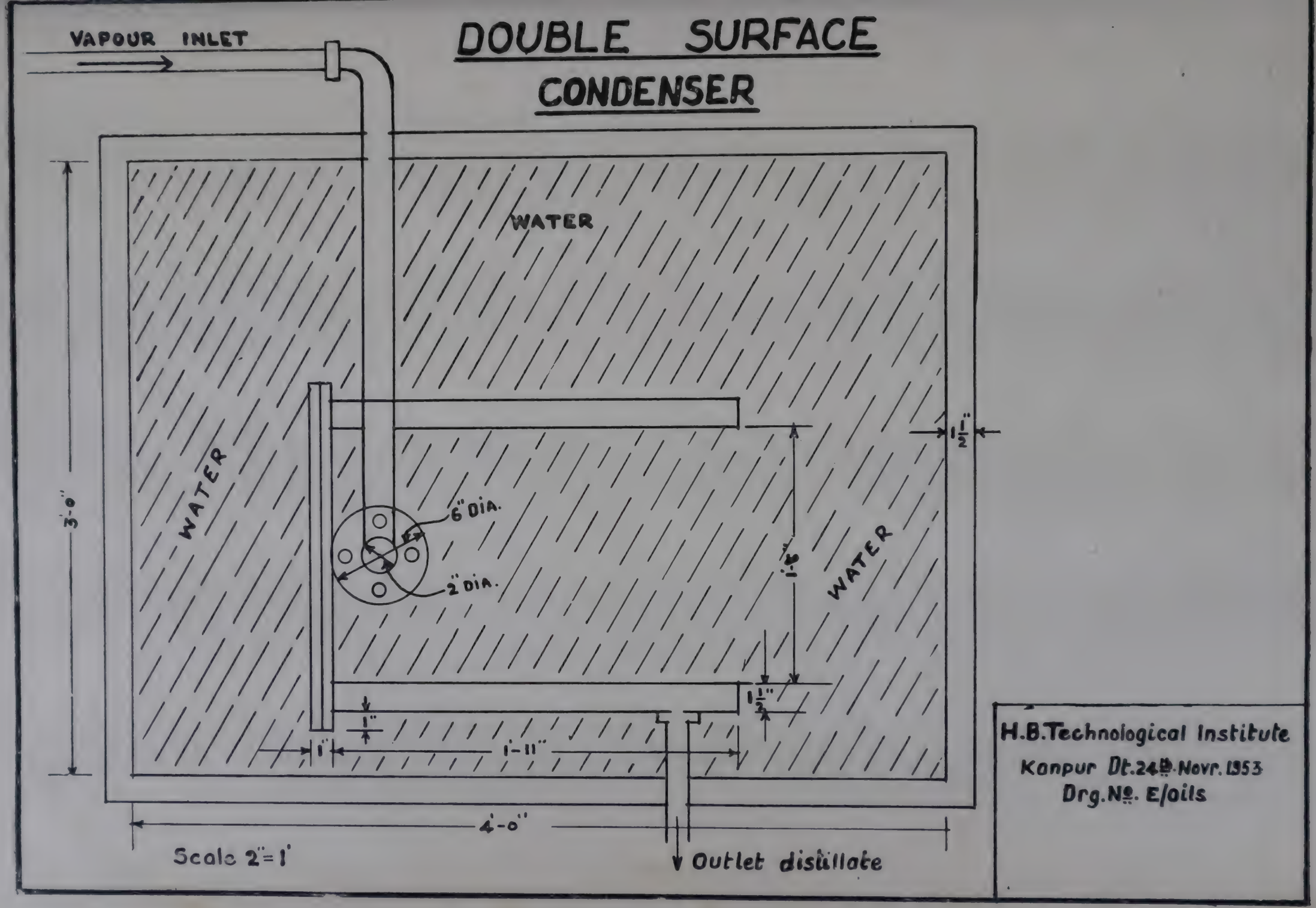

DOUBLE SURFACE
CONDENSER
VAPOUR INLET
WATER
WATER
WATER
6" DIA.
2" DIA.
3'-0"
1½"
1'-8"
1½"
1"
1"
1'-11"
4'-0"
Scale 2"=1'
Outlet distillate
H.B.Technological Institute
Kanpur Dt.24th Novr. 1953
Drg.No. E/oils

Diagram D

TABLE No. 10

Name of Flower	Place	Yield % of oil
1. Rosa Damascena	Ghazipur ..	0.04 %
Ditto	Hassayan (Aligarh) ..	0.02—0.025 %
2. Kewda (Pandanus Odoratissimus) ..	Kolapalli (Ganjam) ..	0.03 %
Ditto ditto ..	Meghna ..	0.028 %
Ditto ditto ..	Agraram ..	0.03 %
Ditto ditto ..	Ghazipur ..	0.015 %
3. (Jasminum Sambac) Bela	Kannauj ..	0.02—0.022 %
Ditto	Sikandarpur ..	0.023 %
Ditto	Ghazipur ..	0.02—0.022 %
Ditto	Hassayan ..	0.02—0.022 %
Ditto	Kanpur ..	0.022 %
4. Chameli	Kannauj ..	0.021—0.022 %
(Jasminum Graniflorum)	Ghazipur ..	0.02—0.022 %
Ditto	Kanpur ..	0.02—0.25 %
5. Champa (Michelia Champaca) ..	Parlakimedi (Orissa)	0.06—0.07 %
Ditto	Kolapalli (Orissa) ..	0.06—0.064 %
6. Spearmint leaves (Mentha Spicta) ..	Kanpur	0.2—0.25 %
Ditto ditto ..	Dehra Dun ..	0.13—0.15 %
Ditto ditto ..	Lucknow ..	0.13 %

	Place	Yield of oil tolas in 1 maund	Percentage yield
7. Vetiver (*Khas*) roots (Vetiveria Zizanioides Stapf.)	Bharatpur	.. 6—8 tolas ..	0.19—0.25 %
	Dholpur ..	.. 4—6 tolas ..	0.12—0.19 %
	Math (Mathura)	.. 6—8 tolas ..	0.19—0.25 %
	Biswan (Sitapur)	.. 4—6 tolas ..	0.12—0.19 %
	Pilibhit	.. 5—7 tolas ..	0.16—0.22 %
	Kaurialaghat	.. 8—10 tolas ..	0.25—0.31 %
	Musanagar (Kanpur)	2.5—3 tolas ..	0.08—0.1 %
	Travancore Cochin ..	10—13 tolas ..	0.31—0.41 %

The above results have been calculated on the air dried roots and the khas roots distilled included the knots and stems together with small quantities of dust.

At H. B. T. I., gardens, different varieties of roses have been cultivated and the percentage yield of oil in them determined by distillation alone.

TABLE No. 11

Name	Percentage yield
1. Rose fasli (Rosa Domascena)	0.015—0.02 %
2. Rose Edward (Rosa Bourbonica)	0.011—0.012 %
3. Rose Teplit.	0.01—0.012 %

By extracting the distillation waters after removing the oil with a solvent the above yields of otto are increased by 25—30 per cent.

The two most commonly occurring varieties of marigold plants with yellow and red flowers were cultivated in the gardens and the percentage yields of oil in the flowers and leaves were determined.

TABLE No. 12

Name	Percentage yield
Marigold flowers Yellow (Tagetes Erecta)	0.016—0.018 %
Marigold flowers red (Tagetes Patula)	0.015—0.019 %
Margiold leaves (T. Erecta)	0.05—0.07 %
Marigold leaves (T. Patula)	0.09—0.1 %

Examination of essential oils:

(1) *Citrus Oils*—Cultivation of citrus fruits on a commercial scale has taken place during the last fifty years. India produces 13.5 million maunds of citrus fruits grown in an area 1,30,011 acres which is 6.5 per cent. of the total area of 2 million acres under all fruits in the country. The principal citrus fruit growing states in India are Madras, Uttar Pradesh. Punjab, Bombay, Assam and Coorg. The average yield of citrus fruits is 98—100 maunds per acre.

[Photograph No. 6 and No. 7.]

Malta oranges are cultivated at Gujranwala, Renalakhurd and a few other places in Punjab.

Karna Khatta fruits grow wildly in the hilly regions of Uttar Pradesh, i.e., Almora and Garhwal and are not utilized commercially.

Citrus oils are extensively used in flavouring and perfumery trades. They are of three types :

(1) Prepared from the peels of the fruits and are named after the fruits. Thy are generally made by the expression methods and rarely by distillation.

(2) Prepared from the flowers called neroli oils.

(3) Prepared from the leaves and twigs called petitgrain oils.

Some citrus and petitgrain oils were prepared in the laboratory by the distillation method as the fresh peels could not be obtained. The oils were also prepared from the leaves of some citrus plants. The following oils were prepared and examined :

(1) Oil from the peels of Karna Khata.

(2) Oil from the peels of malta oranges.

(3) Ptitgrain oils from the leaves of citrus aurantium (Karna Khatta), citrus reticulata (Narangi) and citrus limettoides (Meetha Nibu).

The experimental details are given in the following table :

TABLE No. 13

Particulars	Oil from the peels of		Oils from the leaves and twigs of		
	Malta oranges	Karna Khatta	Citrus Aurantium	Citrus Reticulata (Narangi)	Citrus Limettoides (Meetha Nibu)
1. Percentage yield of oil.	3.3 % (dry basis)	1.13 %	0.25—0.28 %	0.31 %	0.18 %
2. Sp. Gr. at 20°C	0.8478	0.8468	0.8663—0.8676	0.9015	0.8783
3. Refractive Index at 20°C.	1.4705	1.4690	1.4729—1.4739	1.4907	1.4772
4. Optical Rotation.	113.03'	93.78'	48.24—43.26'	1.4'	38.7'
5. Acid Value ..	1.43	3.4	1.47—5.71	1.65	8.96
6. E.ster Value ..	1.28	17.6	35.9—46.8	12.9	55.42
7. E. V. after acetylation.	..	28.0	125—165.2	111.9	143.3
8. Aldehydes calculated as citral.	0.44 %	2.1 %	17.6—19.5 %	3.7 %	12.89 %
9. Solubility ..	..	..	0.5 vols. of 90% alcohol.	2 vols. & more of 90% alcohol.	0.5 vols. of 90% alcoohl.
10. Terpenes chiefly limonene.	93.52 %	91.77 %	25.5—30.5 % (Limonene and dipente e)	38.91 % (Limonene and dipentene)	26.54 % (Limonene and dipentene)
11. Alcohols as linalol.	0.93 %	1.09 %	26.46—34.29 %	29.39 %	25.86 %
12. Linalol by formylation.	..	..	19.5—28.6 %	28.66 %	16.42 %
13. Methyl Anthranilate.	0.39 %	0.06 %	..	..	..
14. Esters as Linalyl acetate.	..	0.75 %	12.55 %	4.5 %	19.38 %
15. Citroptene	..	..	..	1.87 %	Traces.

The composition of some orange oils are also given below for the sake of comparison. It may be seen that their composition closely resembles with that of Karna Khatta which grow wildly in the hilly regions of Uttar Pradesh as has already been mentioned above. Therefore the Karna Khatta oil can be employed in confectionary, aerated waters and soaps, etc., in place of orange oils.

TABLE No. 14

Particulars	Sylhet orange oil (hand pressed)	Coorg orange oil (cold pressed)	Nagpur orange oil (distilled)	Coorg orange oil (distilled)	Coorg orange oil (Raw peels)
1. Specific Gravity ..	0.8413 (18°C.)	0.8553 (18°C.)	0.8501 (15°C.)	0.8494 (18°C.	0.8476 (18° C.)
2. Refractive Index ..	1.4730	1.4730	1.4680	1.4750	1.4700
3. Optical Rotation ..	113.30	114.30	95.03	114	114
4. Limonene ..	94.54 %	94.06 %	90.8 %	93.58 %	94.63 %
5. Methyl anthranilate ..	0.2 %	0.12 %	0.8 %	0.17 %	0.32 %
6. Crystalline Wax ..	0.56 %	0.21 %	Trace ..	..	..
7. Linalool ..	..	0.18 %	1.8 %	1.01 %	0.64 %
8. Residue	2.0 %	2.5 %	1.9 %	1.33 %	..
9. Undertermined ..	3.1 %	Nonyl caprylate— 2.04 % and unidentified 0.82 %	4.0 %	3.91 %	Citral 0.48 % unidentified 0.93 %

(2) *Flower Oils*

(i) *Otto of Kewda or Pandanus Odoratissimus L.*—The pandanus odoratissimus L., is the only aromatic member of the N. O. Pandanacea. It is called in Sanskrit—Ketaki, Dhuli Puspika ; English—Fragrant screw pine, Hindi—Keora, Gagandhul Kewda, Bengali—Kewra ; Ketuki ; Bomb. Meh—Kevda, Tel—Mogili, Gajangi, Ketaki, Tamil—Talamchedi, Tazhai Kedagai and Guz. Kewoda.

[Photographs No. 8 and No. 9.]

It is a shrub with fragrant flowers found in India, Arabia, Persia, Burma and Andaman islands. Kolapalli, Meghna, Agraram in the Ganjam district in Orissa, Kotabambali in Madras State, Jaunpur, Ghazipur and Sahaswan in Uttar Pradesh and Alwar in Rajasthan are the centres of production.

The superior quality of flowers yielding an excellent odour are met in Ganjam district, which supplies more than 90 per cent. of the total production of flowers in India. The average height of the plant is 12 feet to 18 feet and in exceptional cases goes up to 25 feet high. In South Orissa, they grow wild and the farmers keep them around their fields to serve as fencing.

PHOTOGRAPH NO. 7

Citrus Aurantium (*Karna-khatta*)

PHOTOGRAPH NO. 8

Kewda Flower

PHOTOGRAPH NO.

Kewda Plant

The plants are grown in Uttar Pradesh at a distance of 15–25 feet apart from each other and each plant produces about 20 flowers. The flowers are 10–20 inches long with an average weight of 100–120 grams without leaves.

The total quantity of flowers used by perfumers in South Orissa is about 40 millions per annum and in Jaunpur and Ghazipur about 80 pounds. (The flowers in these districts are sold by weight). The flowering season lasts from May to October.

In India the flowers are used mainly for the manufacture of Kewda water and Kewda Attar. Kewda Attar is very popular in the country. The Otto of Kewda, as is known in South Orissa is not the real otto or oil as it is based in Palmarosa oil. Sadgopal extracted a light yellow oil in an yield of 0.1 to 0.3 per cent. on the weight of flowers having an odour of strong typical oriental character. Deshpande also prepared and examined the Kewda oil. The characteristics of the oils prepared by them have been given in the table. The attar is used in high class perfumes and in special ceremonies.

The oil was prepared at Meghna, Kollapalli, Agraram in Ganjam district and at Ghazipur. The oil was prepared by the improved method already mentioned bove.

The characteristic properties of the oil so produced were as follows :

TABLE No. 15

	Particulars	Kola-palli no. 1	Kola-palli no. 2	Kola-palli no.3	Meghna	Agra-ram	Ghazi-pur	Sadgopal	Deshpande
1.	% yield of oil	0.03	0.031	0.03	0.028	0.03	0.015	0.1—.3	0.06
2.	Sp. gr. at 20°C	0.9584	0.9511	0.958	0.9571	0.9577	0.9320	1.088—1.0884 at 15° C.	0.9373 at 18°C
3.	Ref. Index at 20°C	1.4863	1.4854	1.4912	1.4856	1.4880	1.4870	1.5220—1.5224 at 20°C.	1.4950 18° C.
4.	Optical rotation	1.65	1.67	2.08	1.63	1.68	1.35	Nil	Nil
5.	Acid Value ..	1.40	3.4	2.36	3.6	1.87	6.7	..	..
6.	Ester Value	40.9	39.4	15.9	33.83	20.59	20.1	..	..

It may be seen that the percentage yield of Otto from Kewda flowers at Ghazipur is nearly the half to those obtained at other places in South Orissa.

One of the oils prepared at Kolapalli was examined in detail and the various constituents present in it were determined. The oil has been found to contain methyl ether of phenyl ethyl alcohol 66.68 per cent.

Dipentene	6.24 %
d—Linalool	19.16 %
Phenylethyl acetate	4.65 %
Citral	1.82 %
Acids as caproic acid	0.49 %
Stearoptene	0.2 %

The presence of Phenyl ethyl alcohol and ester of Phthalic acid was also detected in the oil.

(ii) *Rose oil or Otto of Rose*—There are more than 100 varieties of roses but for perfumery purposes only the following are cultivated :

(1) *Rosa Alba L.*—It is harder and more resistant to unfavourable climatic conditions.

(2) *Rosa Damascena Mill*—Has large pink flower usually grown in Bulgaria, India, Persia, etc.

(3) *Rosa Centifolia L.*—Has pinkish flowers. It grows at Grasse in France and Morocco and contain a good amount of flavour oil.

In India there are mainly 2 types of roses which are grown on large scale for commercial purposes. (*a*) Rosa Damescena Mill called "Fasli" which is used for making rose water, Otto of Rose and rose attar. (*b*) Bourbon hybrid perpetual or Edward called "Cheenia" used for making gulkand and rose attar but not generally for otto of rose.

The chief centres of cultivation of rose flowers are Burmana and its neighbouring villages in Aligarh district, Kannauj, Ghazipur, Kanpur, Sikandarpur (District Ballia) all in Uttar Pradesh.

In Madras State Edward rose flowers are available in the districts of Chingelpet, Tanjore, Trichnopoly and Madura. The total area being about 260 acres. The flowers of this area are not put to any commercial utility except as offering to deities or personal decoration.

There are two seasons of Rose flowers, viz., (1)—March—Apirl and (2) September—October.

During March/April, 15,000 to 20,000 maunds of rose flowers are obtained in Aligarh district for making rose water, rose oil and gulkand, etc. Nearly half the quantity is used for making rose water and about a quarter for rose attar, while the rest is used for rose oil, Gulkand and allied products.

About 4,500 to 5,000 plants are grown per acre when cultivated systematically at 3 feet apart. In Aligarh, about 3,000 plants and at Kannauj 2,500 plants are grown per acre. The average life of a rose plant is about 10 years and the yield of flowers is maximum from the 4th year onward.

The flowers should be plucked early in the morning before sunrise to obtain the maximum yield of oil.

To study the yeild of oil or otto, four types of rose flowers, e.g., Rosa Demascena, Rose Edward, Rose teplitz and His Majesty Rose were distilled and examined at various centres. The flowers were also extracted with solvents and the concretes were steam distilled. The experimental results are given below :

TABLE No. 16

Variety of flowers	% yield of Otto	% yield of concrete	% of steam volatile constituents in concrete
Faslî rose (Rosa Damascena)	0.015—0.02	0.24—0.34	18—20
Cheenia Rose (Rose Edward)	0.01—0.015	0.15—0.26	15—20
Rose Teplitz	0.01—0.014	0.18—0.23	15—20
His Majesty rose ..	0.015	..	..

Otto from two varieties, i.e., Rose Edward, Rosa Damascena (Aligarh and Ghazipur), were analysed in detail. The characteristic properties of the oils are as follows :

TABLE No. 17

Particulars	Ghazipur Rosa Damascena	Aligarh Rosa Damascena	Kanpur Rosa Edward	Rose oil from Bulgaria
1. Sp. gravity at 30°C. ..	0.9219	0.9389	0.9625	0.8605—0.8485
2. Ref. Index at 30°C. ..	1.4850	1.4860	1.5015	1.453—1.464 at 25° C.
3. Opt. Rot.	..	—2.4	—1.2	—2.3 to —4.4
4. Acid value	4.3	5.5	5.8	7.2—17.2
5. Ester Value	17.3	63.9	33.9	8.0—20.75 S.V.
6. Ester Value after Acetylation ..	277.1	264.6	278.7	197.87—233.33
7. Free Alcohols as Geraniol ..	86.85 %	65.01 %	80.08 %	62.90—75.50 %
8. Combined Alcohols ..	4.8%	16.48%	9.42%	2.0—4.7 %
9. Citronellol by formylation ..	..	58.9 %	..	30.5—58.6 %
10. Stearoptene	7.6 %	11.89%	9.7 %	18.2—21.3 %
11. Congealing point	+21°C.	+22°C.	+28°C.	16.5—22.5°C.

(iii) *Jasmine Oils*—The jasmine flowers have been valued since long in perfumery on account of their peculiar, mild and pleasing odour. Every high class perfume has a touch of jasmine perfume. There are nearly one hundred varieties of jasmine mostly natives of India, Arabia, China and Egypt, etc. In India, the jasmine flowers are used for making hair oil and attars and for making garlands for personal decoration and also offerings to deities.

Species and Varieties—The following varieties of jasmine are commonly found in India, out of which the first seven are grown in Uttar Pradesh :

(1) Jasminum Arborescene,
(2) Jasminum Grandiflorum,
(3) Jasminum Auriculatum,
(4) Jasminum Humile,
(5) Jasminum Ajonicum,
(6) Jasminum Pubescene,
(7) Jasminum Sambac,
(8) Jasminum Undulatum,
(9) Jasminum Revolutum.

[Photograph No. 10.]

Four varieties of jasmine namely, J. Auriculatum (Juhi), J. Grandiflorum (Chameli), J. Sambac (Bela) and J. Ajonicum (Moghra) are cultivated in Uttar Praedsh. The total area under cultivation of different varieties of jasmine flowers in U. P., has already been given above. J. Auriculatum is known as Mugdhee in Sanskrit, Gunika, Yodthika, Umbustha in Bengali and Jui or Juhi in Hindi. It is a shrub with twinning small leaves, set opposite to one another. The flowers are white and sweet smelling with calyx, five notched having round firm glandular process on the outside of each.

Jasminum sambac is called bela in Hindi, Batmogri in Gujrati and Marathi, Zambak in Persian, Mallikaphul in Bengali and Malligai in Tamil and is cultivated in Arbia and India. The flowers of J. Sambac closely resemble with jasminum ajonicum or moghra. Its leaf is oval shaped and flowers are similar to those of J. Grandiflorum. The flowers have double or treble calyx each having 6–8 white petals.

[Photographs No. 11, No. 12, No. 13.]

Jasminum Grandiflorum is known as Jati in Sanskrit, Chambeli in Hindi, Ghambeli in Guz., and English—the Spanish Jasmine.

It is large glabrous shrub, erect while young and climbing or scrambling when older. Branches ribbed. Flowers are white numerous rounded, delightfully fragrant, with faint pinkish streaks outside often tinged with purple.

Two varieties of J. Grandiflorum or chameli are available in the State, one with a yellowish green stem and perfectly white petals 5 in number and the other with light green stems having violet colour in the corners on the backside. The first type of flowers are usually available at Kannauj while the second variety at Sikandarpur, (District Ballia), Ghazipur and Jaunpur.

PHOTOGRAAH NO. 10

Chameli flowers

PHOTOGRAPH NO. 11

Bela Flower

PHOTOGRAPH NO. 12

Moghra Flower

All types of jasmine plants thrive well in a land where irrigation facilities exist. The land should be exposed to sun and not shaded by trees. The soil should be neither too damp nor too dry. The ideal soil for plantation is that where cereals have previously been sown for years. The propagation of Jasmine plants is done by cuttings which are transplanted at a distance of 3-4 feet apart in the rainy season in the fields. In one acre there are about 4,000 plants. A jasmine field lasts for 10–15 years but on well drained soil the plantations may last much longer. The bushes should be trimmed every year to facilitate the harvesting of the flowers.

The flowers of J. Auriculaturn are very light and 26,000 flowers weigh one kgm. while 3,000–4,000 flowers of J. Sambac and 10,000–12,000 flowers of J. Grandiflorum weigh the same quantity. The perfumers in India prepare their attars and not the ottos or absolutes from them. In Ghazipur and Jaunpur etc. hair oils are made from chameli and bela flowers. The quantity of juhi flowers available is very small and therefore they are used mainly for making attar. The best method for the extraction of otto from jasmine flowers is the enfleurage method.

[Photograph No. 14.]

The table below gives the yield of ottos obtained from various varieties of jasmine flowers, i.e., bela, juhi and chameli using different methods. The ottos were prepared at centres noted for those particular varieties of jasmine.

TABLE No. 18

Name of flowers	Water Distillation	Steam Distillation	Enfleurage	Solvent extraction
1. J. Grandiflorum (Chameli)	.. 0·02—0·022%	0 025—0·03%	0·18%	0·04%
2. J. Sambac (Bela)	.. 0·02—0·025%	0·03—0 035%	0·15%	0 04%
3. J. Auriculatum (Juhi)	.. 0·02	0·03%	0·146%	..

The quality of the ottos depend on the following points :

(1) During warm and sunny weather the flowers give a better yield and quality of oil than during cloudy and particularly rainy weather.

(2) During the height of the season (Second half of August and middle of October) the yield and quality of flower oil are higher and superior than at the beginning or at the end of the season.

(3) Flowers picked in the morning up to 10 a.m. are of far better quality (yield and perfume) than those collected at noon or in the afternoon.

(4) The flowers should be processed without delay.

(5) The extraction should be done at low temperatures.

Indole, the chief constituent appears to be present in the buds in the form of a complex compound. As soon as the buds open in the morning, the indole is freed and evaporated into the atmosphere at a rate of 0.6—0.8 mg. per 100 grams of flowers per hour. In the morning 100 grams of the flowers contain on an average 5 mg. of indole. Towards the evening when the flowers close, the indole disappears and reappers again in the morning.

The ottos were prepared at his Institute by water distillation method and treating the distillates with solvents which were later on removed. Jasmine flowers were also extracted with solvents. The properties of the concretes so obtained are given below :

TABLE NO. 19

Particulars	J. Sambac (Bela)	J. Grandiflo-rum (Chameli)	J. Auriculat-um (Juhi)
% yield of concrete	0·43—0·44%	..	0·41%
Melting point	70°C	55°C	50°C
Congealing point	68—69°C	54°C	48°C
A. V.	3·76	0·23—0·27	9·5
S. V.	176·7	116·2—119·6	230·46
% steam volatile constituents in the concrete ..	10·1—10·5%	10·5—14·5%	..

Properties of the ottos or oils :

Absolute or ottos are yellowish red liquids soluble in 90 per cent. alcohol and possess characteristic flowers notes. On ageing they darken in colour. The characteristic properties are given in the following table :

TABLE NO. 20

Prrticulars	Jasiminum Sambac (Bela)					J. Grandi florum (Cha-meli)	J. Auri-culatum (Juhi)
	Kannauj	Hassayan	Sikan-darpur	Ghazipur	Kanpur		
1. % yeild of Otto	0·02—0·022%	0 023%	0·023%	0·02—0·022%	0·02 0·03%	0·02 0·025%	0 02%
2. Sp. gr. at 30° C ..	0·9727	0·9778	0·9795	0·9797	0·9769	0·9814	0 9548
3. Ref. Index at 30°C ..	1·506	1·507	1·507	1·507	1·506	1·4970	1·5185
4. Opt. rotation ..	—2·2	..	..	..	..	..	..
5. Acid Value ..	6·4	7·6	4·68	1·51	11·36	1·2	7·2

PHOTOGRAPH NO. 13

Bela Flowers

PHOTOGRAPH NO. 14

Juhi Flowers

PHOTOGRAPH NO. 15-A

Champaca Flower

PHOTOGRAPH NO. 15-B

Champaca tree

Particulars	Jasminum Sambac (Bela)					J. Grandi-florm (Chameli)	J. Auriculatum (Juhi)
	Kannauj	Hassayan	Sikandarpur	Ghazipur	Kanpur		
6. Ester Value ..	121.2	126.6	131.52	125.19	129.64	276.8	132.84
7. Esters as benzyl acetate ..	32.45	33.89	35.2	33.52	34.7	74.8%	35.7%
8. S. V. after acetylation ..	239.2	229.8	241.3	235.9	233.7	..	275.3
9. Total alcohol as linalol ..	35.58	30.73	32.90	33.16	30.99	..	43.8%
10. Methyl anthranilate ..	2.88	..	2.97	3.51	3.06	0.45%	6.1%
11. Indole	2.75	..	..	2.82	..	1.75%	2.82%
12. Solubility in 95 % alcohol	One volume in 9 Vols. of 95 % alcohol						Soluble in all pro-portion in 85% Alcohol
13. Benzyl alcohol	..	..	..	..	..	15.46%	..
14. Jasmine	..	..	..	..	..	3.0%	..

(iv) *Oil of champaca* :

The oil of champaca is obtained from the flowers of Michelia Champaca L., which belongs to N. O. Magnoliaceae. It is a tall evergreen tree native of India. It is cultivated as well as it grows wild throughout the South Eastern tropical Asia particularly in India, Java, Phillipines ; Nepal, Bengal, Assam, Nilgiris, Madras and S. Orissa are the main producing regions in India. The tree is 15–25 ft. high 2 ft. in diameter and bears golden yellow flowers.

The tree is known as champaca of Kusum in Sanskrit, Golden yellow Champa in English ; Champac in French, Champa in Bengali and Hindi ; Senchampa in Marathi ; Sampang in Tamil, Gulia Champa in Nepal, Rae champa in Gujrati and Sampige in Canarese.

Besides possessing pharmaceutical properties, the flowers contain an essential oil. In S. India the flowers are used as offerings to deities and also for personal decoration. The tree is frequently planted near the temples and is considered sacred.

[Photograph No. 15.]

The tree is propagated either from the seed or cuttings on sandy soils planted at a distance of 15–20 ft. apart. The tree flowers after 4-5 years. There are two flowering seasons per year, (i) April and (ii) September-October.

The average yield of flowers per tree is 200–300 flowers per day during the season. Owing to the presence of an oxidising ferment in the flowers, they become brown in few hours after being picked hence to prevent its odour being impaired, the oil must be prepared soon after picking. The flowers have eight golden yellow rolled petals. In S. India Pertappur, Parlakimedi and Jaspur (S. Orissa) are the production centres of flowers. About 2 million flowers weighing nearly 120 mds. are produced every year and 375–425 flowers weigh one kilogram.

In India, no attempts appear to have been made so far for the preparation of Champa oil. Indian perfumers make champa attar. Experiments were, therefore, made to prepare Champa oil. Solvent extraction method was also used to prepare the oil using benzene as a solvent.

As these flowers are eisily available in S. Orissa experiments were, therefore, conducted at Parlakimedi (District Ganjam) in the month of September–October.

The oil was obtained in an yield of 0.064–0.067 per cent. on the weight of fresh flowers.

The oil of Champa had the following physicochemical properties :

TABLE No. 21

	Sample no. 1	Sample no.2
Sp. Gr. at 30°C—	0.9930	0.9614
Ref. Index at 30°C	1.4959	1.4925
Optical Rotation	7.2	dark
Acid value	6.22	4.17
Sap. value	77.23	69.02
Ester value	71.01	64.85
Ester value after acetylation ..	120.8	129.8
Solubility in 90 % alcohol	Soluble in equal vols but becom e: slightly turbid on further addition.	

The oil did not dissolve in 70 per cent. alcohol. The concrete from the flowers was prepared by the solvent extraction method. The yield of the concrete was 0.26 per cent. and gave 26.3 per cent. of steam volatile oil on steam distillation. It had the following physical properties.

M. P.	29°C.
Congealing point	28°C.
Acid value	29·1
Sap. value	177·2

PHOTOGRAPH NO. 16

Marigold (yellow) or T. Erecta Flowers

PHOTOGRAPH NO. 17

Marigold yellow or T. Erecta Flowers

PHOTOGRAPH NO. 18

Marigold yellow or T. Erecta Flowers

PHOTOGRAPH NO. 19

Marigold red or T. Patula Flowers

To determine the composition of champa oil it was fractionated under vaccum. Only a small quantity of oil was taken to see whether the oil resinified or not as was pointed out by Brooks. It was observed that no resinification of the oil took place in the fractionation of the oil.

The oil was found to contain cineol, isoeugenol, phenyl-ethyl-alcohol, benzaldehyde and methyl anthranilate.

(v) *Marigold flowers oil* :

There are a number of varieties of plants commonly known as marigolds (Tagetes) bearing flowers from golden yellow to dark red. They belong to the family compositae and are mostly annuals. The important species of tagetes are T. Patula, T. Erecta, T. Grandulifera. T. Signata, T. minuta and T. Lucida, etc.

[Photograps Nos. 16, 17 and 18.]

It is called genda in Hindi and Bengali, Gendu in Orriya, Tangla metok in Punjabi, Makhmal Gule Jafri in Bambay, Roji Chapful in Marathi, Banti in Telegu and Marigold in English.

Tagetes can be broadly divided into two groups for garden purposes according to the nature of the growth.

1. T. Erecta and T. Lucida which grow upright and are of somewhat open growth.

2. T. Patula and T. Signata which grow in the form of bushes, the lower branches being very close to the ground.

T. Erecta plants are not suitable for bedding purposes on account of their open growth. They should be grown with plenty of space for roots to spread, air and rich soil to get flowers of double variety and bigger in size. This plant is a hardy annual growing 3–4 ft. in height with leaves much bigger than those of T. Patula. The colour of the flowers varies from light sulphur yellow to reddish yellow. The flowering season is from last week of November to January.

T. Patula flowers are dark red in colour and are late blooming. The flowering season lasts from January to March. The plant is $2\frac{1}{2}'$ in height and forms a compact bush. The yield of flowers per acre varies from 80–100 maunds.

[Photograph No. 19.]

All the parts of the above plants contain essential oil. The essential oil from flowers has been found to be a fly repellent. In India, these flowers are used for making garlands to decorate the idols in the temples, etc. The juice of the flowers is sometimes used as a blood purifier and as a remedy for piles.

The yield of oil from the flowers varies from 0.015–0.02 per cent. The oils are reddish yellow in colour and possess characteristic marigold odour. They have a tendency to polymerise readily in presence of air. The oils from leaves and stems are greenish yellow in colour,

The properties of the oils are given below :

TABLE NO. 22

Particular	Essential oil from T. Erecta using			Essential oil from T. Patula using		
	Flowers	Leaves	Stems	Flowers	Leaves	Stems
1. Percentage yield of oil	0·017—0·018%	0·05—0·07%	0·009%	0·018—0·02	0·09—0·1%	0·03%
2. Sp. gr. at 30° C ..	0·9360	0·9526	0·9093	0·9326	0·9416	0·9034
3. Refractive Index at 30° C	1·5025	1·5027	1·4975	1·5069	1·5054	1·4981
4. Opt. rot ..	1·2	4·2	—6·6	—1·2	+2·4	..
5. Acid value ..	5·4	2·3	12·7	5·6	9·01	9·08
6. Ester value ..	33·5	50·2	30·8	45·09	31·13	26·0
7. E. V. after acetylation	119·4	113·57	124·1	106·09	98·70	88·53
8. Carbonyl compounds as $C_{10}H_{16}O$ by still man. Read Method.	23·5%	45·9%	24·5%	39·2%	33·67%	29·29%
9. Solubility in alcohol ..	all the oils are soluble in equal vols. of 90 % alcohol.					

(*vi*) *Essential oils from Kadamb, Moulsari, Harsinghar and Night Queen Flowers*

India abounds in a number of perfume bearing flowers, some of which have not yet been worked out for their essential oils. A few of the flowers, e.g. Kadamb (Anthocephalus Cadamba), Harsinghar (Nyctanthes Arbortristes), Moulsari (Mimusops Elengi) and queen of night (Cestrum Nocturnum) have been distilled in places renowned for them and their oils prepared and examined. A short summery of the work done is given below:

[Photograph No. 20.]

Anthocephalus Cadamba Miq. or Kadamb.—It belongs to N. O. Rubiaceae family. It is called Kadamba, Halpriya, Sisupala or Nipa in Sanskrit, Kadamb in Gujrathi, Bengali and Hindi ; Vellai Cadamba in Tamil, Rudraksh Kamba or Kadambamu in Telgu, Kadam in Marathi, Raghu in Assam, Man-lettan-she in Burmese and wild cinchona in English.

The tree is found all over India and grows wild in Northern and Eastern Bengal, Pegu and the western Ghats. It is cultivated in North India, especially in Nandgaon, Bersana, Kosi Kalan and Brindaban all in Mathura district of Uttar Pradesh. It thrives well in drained alluvial soil. It is considered to be a sacred tree. It is a large deciduous tree about 30—40 ft. high and 5—7 ft. in girth with horizontal branches rather drooping at the ends.

The flowers are numerous, conspicuous, round in shape, 1—2 in. in diameter, terminal, scented at night, simple. It is yellow or orange coloured with white stigmas.

PHOTOGRAPH NO. 20

Kadamb Flowers

PHOTOGRAPH NO. 21

Harsinghar Flowers

PHOTOGRAPH NO. 22

Moulsari Flowers

PHOTOGRAPH NO. 23

Night Queen Flowers

PHOTOGRAPH NO. 24

Peppermint

The Kadamb blossoms at the end of hot season and produces very beautiful flowers. The blossoming period is July and lasts for about a month. The flowers are generally used as offerings to the Gods and not put to any commercial utility. The flowers emit a fascinating perfume. A study was, therefore, made to extract the essential oil from them and study its properties. Flowers weight 8.5 to 11.5 gms. each. As the flowers are available in Mathura District in plenty, a party was sent there for the extraction of the oil.

Mimusops Elengni or moulsari.—It belongs to N. O. Sabatacease. It is called Sinhakesara, Bakula in Sanskrit, Moulsari, Molsari in Hindi, Bakul in Bengali, Ranjansal in Marathi, Pogadamanu in Telgu, Vakulam, Mogadam in Tamil, Khraja in Burmese, Bholsari, Gholsari in Gujrati and Affengesict in German.

[Photographs Nos. 21, 22 and23.]

It is a large evergreen ornamental tree about 50 ft. in height. It is found wild in the forest of South India, Burma and Malaya Peninsula. It is cultivated in Northern India. Its flowers are very fragrant. The fragrant smell of the Carolla persists long after drying. The flower is white, fragrant, solitary actinomorphic symetry. The main season of the flowers lasts from May to June in South India and July to September in North India. The flowers are very light and weigh 0.065—0.07 grams each.

In India the flowers are used for making garlands either for personal decoration or as offering to deities. A small quantity of flowers is used for making moulsari attar. Its essential oil has been distilled from the flowers and analysed. The oil was prepared at Sakhigopal (Distt. Puri, Orissa), as these flowers were not available at Kanpur.

Nyctanthes Arbortristes or Harsinghar.—It belongs to the N. O. oleaceae It is called Parijata, Siphalika, Rajanikasa in Sanskrit, Night jasmine, weeping Nyctanthes in English, Harsinghar in Hindi, Seoli or Shiuli Singhar in Bengali, Kuri, Laduri in Punjab, Partaka, Khursali in Marathi, Shwetasurasa Payalamully in Telgu and Manjapu, Pavala, Pavala Malligai in Tamil.

It is a large shrub 15—25 ft. high and is cultivated throughout India. It is found wild in the forests of Madhya Bharat and Sub Himalayan region, Burma and Ceylon.

The flowers possess a cylinderical tube orange red in colour with white spreading limbs.

The flowers generally open in the night and fall to the ground on the following morning. They contain an essential oil similar to jasmine. The flowers are used as offerings to the deities. They are not distilled for making otto or oil. A small quantity of flowers is consumed for making attar of Harsinghar at Ghazipur and hence its oil was prepared and analysed.

The flowers are very light in weight and each flower weighs 0.25—0.3 gms. The blossoming period begins in the month of September and lasts till October. The experiments were made at Ghazipur as the flowers were available there in abundance. The details are given in the table.

Cestrum Nocturnum.—It belongs to Solanaceae family. It is called Ratki Rani in Hindi, Queen of night or nightjasmine in English and Hasnu Haria in Bengali. It is an evergreen shrub 3—5 ft. high. Flowers bloom at intervals throughout the year and emit very fragrant odour at night. It thrives best in tropical climate of America, India and West Indies.

The flowers are greenish white in colour. The plant gives abundant flowers in the months of April, July, September and November. They are propagated by cuttings in February or early in March and transplanted in July. The trees are prunned in the month of December or January.

As the flowers are not commercially employed but allowed to wither and fall from the plants. Its oil was, therefore, prepared and its properties studied.

The oils from each type of flowers were prepared by distilling them by water distillation method and extracting the distillate with a solvent. The slovent was later on separated and distilled off. The last traces of the solvent were removed by distillation under vacuum. The flowers were also extracted with solvents and their concretes prepared. The concretes were then steam distilled to get the oil. The observations are given below:

Weight of 1,000 flowers.

1. Moulsari .. .. 65—75 grams.
2. Kadamb .. .. 8,000—11,000 grams.
3. Night queen .. .. 20—30 grams.
4. Harsinghar .. .. 250—300 grams.

TABLE No. 23

Particulars	Kadamb Nandgaon (Mathura)	Harsinghar Ghazipur	Moulsari Sakhigopal (Puri-Orissa)	Night queen Kanpur
%yield of oil by distillation on the weight of flowres.	0·0075%	0·0045%	0·01%	0·0135%
%yield of concrete on the wt. of flowers	0·17%	0·058%	..	0·27%
%otto by steam distillation on the weight of concrete.	2·3%	10·5%	..	8·5%

TABLE No. 24

Analysis of Concretes

Name of flower	Melting pt. °C	Congealing pt. °C	Acid value	Ester value
1. Harsinghar	33—34	30—31	23·5	38·2
2. Night Queen	48—49	44—45	44·75	106·8
3. Kadamb	57—58	52—53	6·8	113·5

TABLE No. 25

Analysis of Ottos (Water Distillation Method)

Particulars	Kadamb	Maulsari	Harsinghar	Night queen
1. Sp. gr. at 35°C	0·9611	0·9594	0·9044	..
2. Ref. Index at 28°C	1·4840	1·4935	1·4825	1·4905
3. Opt. rot	—4·4	+4·4	2·4	—4·4
4. Acid value	13·4	64·5	8·2	68·4
5. Ester value	88·1	154·0	61·3	68·4
6. E. V. after acetylation	..	..	..	131·7
7. Solubility in absolute alcohol ..	equal Vol.	equal vol.	1 Vol. slight turbidity.	Soluble in equal Vol.

(Oils from Leaves)

Peppermint Oil.

Peppermint Oil—Peppermint oil is one of the most useful essential oils. About 2.25 million pounds of the oil are produced annually throughout the world. This is employed for flavouring tooth-pastes, dental creams, mouth washes, cough drops, chewing gums and tobacco. It is also used in confectionary, alcohol liquors and medicinal preparations. It is an excelent carminative, gastric stimulent, antiseptic and preservative. The chief constituent of the peppermint oil is menthol which is isolated from it and sold separately. The entire quantity of menthol and peppermint oil with a value of about Rs.10 lakhs is imported every year from U. S. A., China and Japan in India. Peppermint oil is not made in the country. [Photograph No. 24.]

English and American peppermint oils are obtained by distillation with steam the flowering herb Mentha Piperita Var Vulgaris or blackmint and mentha piperita officinalis or white mint. English oil obtained from the green herb has a good flavour and aromatic odour, while the Japanese and Chinese oils derived from mentha Arvensis. L. are bitter in taste. U. S. A., Russia, Bulgaria, Haity, Hungary, Germany, France and other European countries extract peppermint oil from plants which are mainly descendant of English blackmint. Peppermint plant grows best in deep loamy, rich in human and well drained soils. About 30,000 to 40,000 plants are planted in one acre. For the better growth of plant, well rotten manures or artificial manures containing high percentage of potash should be used. The planting is generally done in spring and also in October. The plants are propagated with root stock or a system of branching. The black mint grows to a height of $1\frac{1}{2}$ to 3 ft. and gives purplish blossoms from late July to early September. Careful weeding after planting is essential. Harvesting should be done when mint is in full bloom in order to otbain the optimum yield of oil of maximum menthol content. Cutting should be done early in the day,

Before distillation, the cut mint is left in the field for 24–48 hours for drying at temperatures ranging from 25-30 degree C. The dried mint yields oil readily on steam distillation. In the case of dry leaves, the distillation is complete within 40–45 minutes while green leaves take about 3 hours for distillation. Oil obtained from fresh leaves bears a delicate and sweet fragrance. The analytical constant of peppermint oils produced in various countries are given below :

TABLE No. 26

Peppermint Oil From

Particulars	American crude oil)	Bulgaria	England	France	Germany
1. Yield of oil ..	23·48 lbs./ acre or 0·67 % on dry leaves.	..	20—40 lbs. per acre.	0·25%	..
2. Sp. gr. at 15°c/15°/C	0·900 to 0·920	0·9102 to 0·9138	0·9035 to 0·9094	0·910 to 927	0·898— 0·915
3. Opt. rot. at 15°c/15°/C	—18 to 34%	—18to 21·15	—22·5 to 29·10	—5 to —35%	—23 to 37
4. Refractive index at 15°c/15°/C	1·4600 to 1·4640	1·4624 to 1·4645	1·4591 to 1·4643	1·462 to 1·4710	1·4580 to 1·4680
5. Menthol ester content%	3·7 to 11·0	4·3 to 6·6	2·3 to 6·2	4 to 21·0	2·8 to 20·8
6. Total menthol% ..	48·65	52·59·3	42·4 to 64·1	45—70	48—81·0
7. % menthone ..	9—25	..	29·2 to 42·1	17·4	..
8. Solubility in 70% alcohol	2·5to 5 vols.	2·75 to 3·5 vols.	..	3·5 vols.	3·5 vols.
9. Remarks ..	The best yield of oil is in Oregon, i.e. 44 lbs. per acre while it is 21 lbs per acre in Michigan.	Quantity of oil excellent.	Green herb is distilled.	Green herb is distilled.	Best oil in Europe.

Mentha Arvensis.—Is a native of China and Japan. These plants thrive well in somewhat sandy soil loose in texture and rich in humus. Planting is done with root cuttings from the end of November to December and transplanting in the beginning of rainy season on cloudy or rainy days when the soil in damp. Maximum yield of herbs is obtained in the 2nd and 3rd year after planting. Harvesting is done on bright and hot days. The plants can be harvested 2-3 times per year.

The oil is obtained by distilling the dried leaves and the yield amounts to 50–60 lbs. of oil per acre. The yield of oil from highly dried leaves is 2.2%, from steam 0.063 per cent., and from the whole plant 1.86 per cent. Oil obtained from flowering mint is nearly golden yellow in colour, while that obtained from pre-flowering mint is a bit darker. It is a bit biter and fresh in taste and contains about 75 per cent. menthol. The physicochemical characteristic of oil from Mentha arvensis are given below :

TABIE No. 27

Observations	Japan natural oil	Japan natural oil	China natural oil	Brazil natural oil
Sp. gr. at 20°C	0·895 to 0·902	0·8997 to 0·9011	0·899 to 0 9091	0·876 to 0·8980
Opt. rot. (20°C)	—29 to—42	—37·11 to —37·29	—30·2 to 37·32	—29° 12 to 42° 48
Re.f. Index at 20C	1·460 to 1·4630	1·4590 to 1·4595	1·4601 to 1·4647	1·4577 to 1·4698
Congealing point	—5 to—28	—15·75 to —18°	..	..
Menthol ester%	3—6	4·74—5·01	1·6	4·5—18·9
Total menthol%	69—91	78·24—82·78	87·4	65·2—88·9
Menthone%	..	11·85—13·75	12·3	..
Acid No.	2	1·1—2·1	..	..
Ester No.	..	17—18	..	..
Yield of menthol by freezing ..	..	54°48′ to 65°56′	..	..
Solubility in 70% alcohol)	2-3 vols.	2-3 vols.	2·5 to 3 vols.	..

Isolation of menthol from the oil.—The method of separation generally consists of three steps (1) formation of menthol crystals by freezing the oil (2) removal of crystals by centrifuging (3) drying of crystals at a low temperature. Natural crude mint oils yield 40–50 per cent. of menthol crystals and 50–60 per cent. of partly dementholised oil. The centrifuged menthol crystals are sometimes washed with water and dried for 36 hours in warm chambers at 26 degrees C., by passing air. It is aso recrystallised to get pure menthol.

Storage of oil.—The addition of 0.17 per cent. of catechol is more effective than Hydroquinone as an antioxidant to preserve the oil as it is easily oxidised and resinified, both of which produce a slight coloration to the oil.

Properties.—Peppermint oil may be colourless or yellowish or greenish in colour. It has an agreeable and refreshing odour and a cooling persistent taste. It becomes darker and more viscid on keeping. The U. S. P. and B. P. specifications for pepermint oil are as follows :

TABLE No. 28

Particulars	U. S. P.	B.P.
1. Esters calculated as menthyl acetate. ..	Not less than 5%	4—9%
2. Total menthol (free and combined) ..	Not less than 50%	..
3. Free menthol	..	Not less than 40%
4. Solubility in 70% alcohol	4 vol.	4 vol.
5. Sp. gr. at 25°C	0·896—0·908	0·897—0·910
6. Optical rotation	—23 to—33	—18 to—30
7. Ref. Index (20°C)	1·4600—1·4710	1·4600—1·4700

Indian Peppermint

Indian mint "Mentha Arvensis" grows wild in the northern and western Himalayan ranges in Kashmir and at Dehradun in Uttar Pradesh. An excellent quality of oil was obtained from the mint grown at Nilgiris Hills several years ago by the Medical Stores Department of the Government of India. B. S. Rao steam distilled mentha Piperita L., grown near Bangalore. The physico-chemical characteristics of the oil are given below along with those obtained by Schimmel and Co.

TABLE No. 29

Particulars.	Schimmel and Co.	B. S. Rao.
Sp. Gr.	0·9230 at 15 C	0·9285—0·9354 at 30°C.
Opt. rotation	+4·31'	+24°to +32·6'
Ref. Index at 20°C	1·4617	1·4754 to 1·4758
Acid No.	0·4	0·5—1·2
Ester No.	21·5	16·7—21·4
Menthol ester..	6·0%	5·8—7·5%
Free Menthol..	32%	19·1—20·5%
Solubility in 70% alcohol ..	10 vols.	..

Experiments conducted at H. B. Technological Institute Kanpur have clearly shown that Peppermint plants (M. Piperita) can be successfully grown in Uttar Pradesh. Farm yard manure was used as a fertilizer. An yield of about 200 mds. of green leaves per acre per year was obtained. The yield of oil obtained was 0.22—0.25 per cent. on green leaves. The chemical properties of the oils distilled at two different periods are given in the table. American

peppermint plants received from Forest Research Institute, Dehra Dun were also successfully cultivated in the fields at Kanpur. The oil was prepared by distilling the plants. The yield of oil was 0.2–0.25 per cent. on the weight of the green leaves. The characteristic properties of the oils are given in the table :

TABLE No. 30

Constants	Indian Variety		American Variety
	July-August	February-March	
1. Colour	Yellowish green	Green	Yellowish green
2. Solubility in 70% alcohol	2—3 vols.	3—5 vols.	2 vols.
3. Taste	Minty	Minty	Minty
4. Sp. gr. at 20° C	0·9113	0·9052	0·9192
5. Opt. rotation	—18° 56′	—16° 84′	—5·2
6. Ref. Index at 20° C	1·4780	1·4652	1·4675
7. Acid Value	2·36	1·65	1·7
8. Ester Value	63·89	32·36	23·47
9. S. v. after acetylation	94·32	114·11	143·0
10. Total alcohols calculated as menthol	26·47%	33·48%	43·16%
11. Ester as menthyl acetate	22·6%	11·4%	8·29%
12. Ketones as methone	3·0%	4·5%	36·52%

Dimethyl sulphide was found to be present in traces in both the samples. The third sample did not give positive test for dimethyl sulphide.

It may be seen that free menthol content in the oil is much lower than that in foreign peppermint oil and therefore, menthol could not be isolated from the oil by simply cooling it in the freezing mixture. To increase the menthol content with a view to isolate it in the crystalline state, the oil was hydrogenated by sodium amalgam. The resulting oil had a higher menthol content, but it too did not crystallise on cooling. On further examination, the presence of neomenthol in the oil was detected which is liquid at ordinary temperature.

Attempts are now being made to import genuine peppermint plants from U. S. A. and Japan through the Indian Council of Agricultural Research and Ministry of Industries and Commerce, Government of India, New Delhi. It is expected that the imported plants will flourish well in hilly districts and Tarai areas. Their plantation in the country will check the import of peppermint oil and menthol and save the national wealth from drainage to foreign countries.

Oil of Spearmint :

Spearmint comprises several varieties of mentha spicta and mentha virides It is called pudina in Hindi, Bengali, Marathi, Guzrati, Sindhi and Telgu. The plant is cultivated throughout India. It is used as a carminative, stomachic and stimulent. It is given in hiccoup, bilious vomitting and flatulence, colic pains and cholera, etc. The oil is a power ful antiseptic and relives toothache. The leaves are used in chutneys to impart flavour.

The plant is indigenous to India and grows throughout the country. The plants require frequent irrigation. The accumulation of much water in the plants is injurious for their growth. This is why spearmint plants are spoiled in the rainy season. In U. P. the season lasts from March till the end of June. There can be two harvests during this period. [Photograph No. 25].

The green leaves are distilled. The yield of oil depends on several factors, e.g. soil, variety of spearmint, manure and locality. The yield of oil varies from 0.20—0.25 per cent. In an acre 25.30 pounds of oil can be obtained.

Spearmint oil improves on keeping. One year old oil being finer and more characteristic in odour and flavour than a freshly prepared sample. The oil should be kept in well stoppered, amber coloured bottles in a cool place protected from light.

The specifications of spearmint oil according to B. P. Codex are as follows:

Sp. gravity	0·925—0·940
Opt. rot.	—30° to—50°
Ref. Index.	1·4800 to 1·4930
Carvone content	42—60%

Several samples of oils were prepared at Kanpur, and also other places in the state. The analytical results are given below. For the sake of comparison, the chemical properties of some foreign oils are also given in the table.

TABLE No. 31

Physico Chemical Properties of Foreign Spearmint Oils

Particulars	Sp. Gr. at 25° C	Opt.Rot.	Ref.Index	Ester value	Carvone%	Solubility	Remarks.
1. American .. (U. S. A.) Oil	0·919 to 0·933	—50° 15′ to—60° 10′	1·4851 to 1·4899	12·4	57 to 71·5	1 vol. of 80%alcohol.	..
2. English Oil	0·926 to 0·935	—39° to —52°	..	..	38—48	1 vol. of 80% alcohol.	
3. Hungarian Oil	0·936 to 0·9444	—38° 15′ to 46° 25′	1·490 to 1·491	..	61—72	2·5 to 5 vols. of 70% alcohol.	..
4. Australian Oil	0·926 to 0·952	—38° to —52°	1·4890 to 1·4930	..	61—72	..	
5. Russian Oil	0·880 to 0·895	—20° to —28°	..	15·25	5—16	2 to 3 vol. of 70% alcohol.	A.V.1-O.; rich in L-Linalool and cineol but poor in carvone.

The physico chemical constants of the spearmint oils prepared at Kanpur and other places in U. P.

TABLE No. 32

Parti culars	Sample No. 1 Kanpur	Sample No. 2 Kanpur	Lucknow Green Leaves	Lucknow dry Leaves	Dehra Dun
1. Sp. Gr. at 30° C	0·9252	0·9271	0·9038	0·9403	0·9920
2. Ref ractive Index at 30° C ..	1·4848	1·4850	1·4908	1·4938	1·5018
3. Opt. Rotation	—57° 11′	—61° 4′	—62° 4′	—57° 4′	..
4. Acid Value	1·17	1·18	..	..	..
5. Saponification Value ..	28·76	28·54	..	..	..
6. S. V. after acetylation ..	76·6	75·98	..	..	..
7. Carvone Contant	58·93%	65·22%	52·8%	68·4%	38·1%
8. Solubility in 80% alcohol ..	1 vol.	1 vol.	1 vol.	1 vol.	..

Palmarosa and Gingergrass Oils :

Palmarosa and ginger grass oils (oils from Cymbopogon Martini Var Motia and Cymbopogon Martini Var Sofia) also known as Rusha grass oils or Motia and sofia oils are valued on account of the presence of geraniol which is one of the main constituents of the otto of rose and is used practically in all high class perfumes. Geraniol being stable in contact with alkali can be used with advantage in all kinds of soaps.

Palmarosa oil containing higher percentage of geraniol (85—95 per cent.) is exported in sufficiently large quantities chiefly for the isolation of geraniol.

Both the varieties occur wild in Madhya Pradesh, Berar, Khandesh, Belgaum, Nasik, Madhya Bharat, Hyderabad (Deccan) and South India. Though both the varieties are closely related they do not grow side by side except in a few places. Motia variety grows in open forests on dry sunny slopes and the sofia in lower altitudes, valleys and in dense moist areas with poor drainage.

A loamy soil is suitable for their cultivation. A well drained clayey soil can also serve the purpose. The grasses can be raised from seeds or from nursery plants. Farm yard compost can be used as a manure. Care should be taken to irrigate the plants regularly so that the plants may not dry up.

The plants should be harvested in October at the time of flowering when the leaves, stems and flowers contain the maximum quantity of oil. Two cuttings per year can be made in July and in October, if the soil is very rich but in general only one cutting is done in October.

The average yield of each grass is about 12,000 lbs. per acre per annum. The flowering tops contain the maximum quantity of oils and next comes the leaves. The whole plant of Motia variety in fresh state yields 0.15-0.17 per cent. oil and that of sofia 0.4–0.42 per cent. on distillation.

The best grades of Palmarosa (Motia) oil containing 90–95 per cent. geraniol are produced in Berar while those prepared in Khandesh contain 80–85 per cent. geraniol. Sofia oil contains much less geraniol, generally about 60 per cent.

Both these variety of plants were cultivated successfully in the fields at Kanpur from seeds received from Chief Conservator of Forests, Madhya Pradesh Nagpur. The experimental observations are given below on the assumption of one cutting per year.

The yield of each grass per acre per annum was 18,000–19,000 lbs.
per cent. yield of oil in Motia variety=0.17 per cent. or 32 lbs. per acre.

The table below gives the physicochemical properties of the oils (Motia and Sofia) prepared by us. The results obtained by Narain and Dass Gupta are also included in the same table.

TABLE No. 33

Particulars	MOTIA OIL			SOFIA OIL	
	H.B.T.I. (1)	H. B. T. I. (2)	Narain and Das Gupta.	H. B. T. I. (1)	F. B. T. I. (2)
1. Sp. gr. at 30°C	0·8880	0·880	0·880—0·886	0·9371	0·9420
2. Ref. Index at 25°C	1·4777	1·4695	1·4720—1·4780	1·4900	1·4910
3. Opt. Rotation	..	..	—3 to 5°	..	+31
3. Acid Value	2·12	1·41	0—3	3·1	3·36
5. Sap. Value	15·2	11·9	..	24·2	48·82
6. Ester Value	13·08	10·5	12—50	21·1	45·46
7. E. V. after acetylation ..	252·1	267.5	..	161·8	196·0
8. Free alcohols as geraniol ..	80·8%	87·5%	..	43·2%	46·7%
9. Combined alcohols as geraniol ..	3·61%	2.87%	..	5·9%	12·96%
10. Total alcohols as geraniol ..	84·41%	90·37%	78—94%	49·1%	59·66%
11. Solubility in 70% alcohol ..	1—3 vols.	1—3 vols.	1—3 vols.	1 in 2 vols	1 in 2 vols.

It can be seen that palmarosa plants can be grown in our state successfully. The oil extracted from them compares favourably with those from Madhya Pradesh. If grown commercially it will be a new source of income to the state perfumers.

Lemongrass Oil.

This grass grows wild and cultivated abundantly in Travancore, Cochine and Tinnevely District in South India. The oil extracted from it is extensively used for perfuming soap and cheap scents. Very large quantities of the oil are exported to foreign countries for the isolation of citral used in the preparation of ionone. Recently a process has been developed to prepare Vitamin A from ionone. The oil has also been shown to be a mosquito repellent.

Owing to its extensive consumption at home and abroad a study was made to grow these plants in U. P. It is a hardy plant and grows in almost any kind of soil. The more fertile the soil, the lower is the citral content, although the yield is high. The plants require little attention. The plants once sown remain in the field for 8-10 years. The roots are left in the field and only the grass is cut off. It is propagated by clumps of fully matured plants and planted in the field at a distance of 2′-3′ apart. It requires a warm typical climate and intermittent rainfall or water. The grass is ready for harvesting after 2-3 months depending on weather conditions. When the plant is about 4 feet high and has 4-5 leaves, it is ready for harvesting. There can be 4-5 cuttings per year. The average yield of oil from 30—50 lbs. per acre per annum.

The green grass is distilled yielding 0.2—0.25 per cent. oil on the weight of fresh grass.

The samples of oils obtained by distilling the grass grown in the fields were analysed. The results are given below. It had been observed that the yield of oil was only 0.14 per cent. in the rainy season and 0.22 per cent. in the summer.

TABLE No. 34

Parti culars	Sample No. 1	Sample No. 2	Sample No. 3	Travancore Lemongrass oil
Sp. gr. at 30°C	0·8846	0·9146	0·8846	0·899—0·911 at 15°/15° C
Ref. Index at 30°C	1·4838	1·4874	1·4816	1·4855 to 1·4899 at 20° C.
Opt. Rotation	..	—1	—0·4	—1° 10′ to —3° 10′
Acid Value	3·9	12·5	5·6	..
Ester Value	20·6	..	..	..
Aldehydes as Citral by neutral sulphite method	75·0%	70·0%	72·0%	71·8—79·1%(Bisulphite method)
Solubility in 70% alcohol ..	2—3vols.	..	2—3vols.	2 to 2·5 vols.

TABLE No. 35

The Indian standards for lemongrass oil are

1.	Colour and appearance	Reddish yellow to brown mobile liquid
2.	Odour	Lemon like.
3.	Sp. gr. at 15/15	0·900—0·910
	Sp. gr. at 25/25	0·892—0·902
	Sp. gr. at 30/30	0·888—0·898
4.	Opt. rotation	—3 to +1
5.	Ref. Index at 25°	1·4786—1·4846
	Ref. Index at 30°	1·4808 —1·4868
6.	Citral % by volume	75
7.	Solubility	Soluble in 70% alcohol.

The citral content of the oils prepared at Kanpur is less than that in Travancore oils which may be due to higher fertility of the soil.

The Essential oil from the leaves and flowers of Ocimum Basilicum.

It is another variety of ocimum and is called "Marua Dauna" in Hindi. It grows wild throughout the country. All parts of the plant excepting the root contain oil especially the leaves and flowers, which emit a very pleasing fragrance. The oil possesses some insecticidal action against house flies, blue bottle flies and especially mosquitoes. The plants were cultivated systematically in the fields at a distance of 2-2½′ apart. Ordinary Loamy or clayey soil is suitable. Farm yard manure can be used. They required frequent irrigation. There can be two harvests per year. The oils were distilled from leaves and flowers separately at different intervals. The flowers yields 18 lbs. and the leaves 12 lbs. oil per acre per year. The yield of flowers or leaves obtained per acre per annum was 6,000 lbs., each. The harxesting is done when the plants flower profusely. The physico-chemical constants and compositions of the oils are given below :

[Photograph nos. 26 and 27].

TABLE No. 36

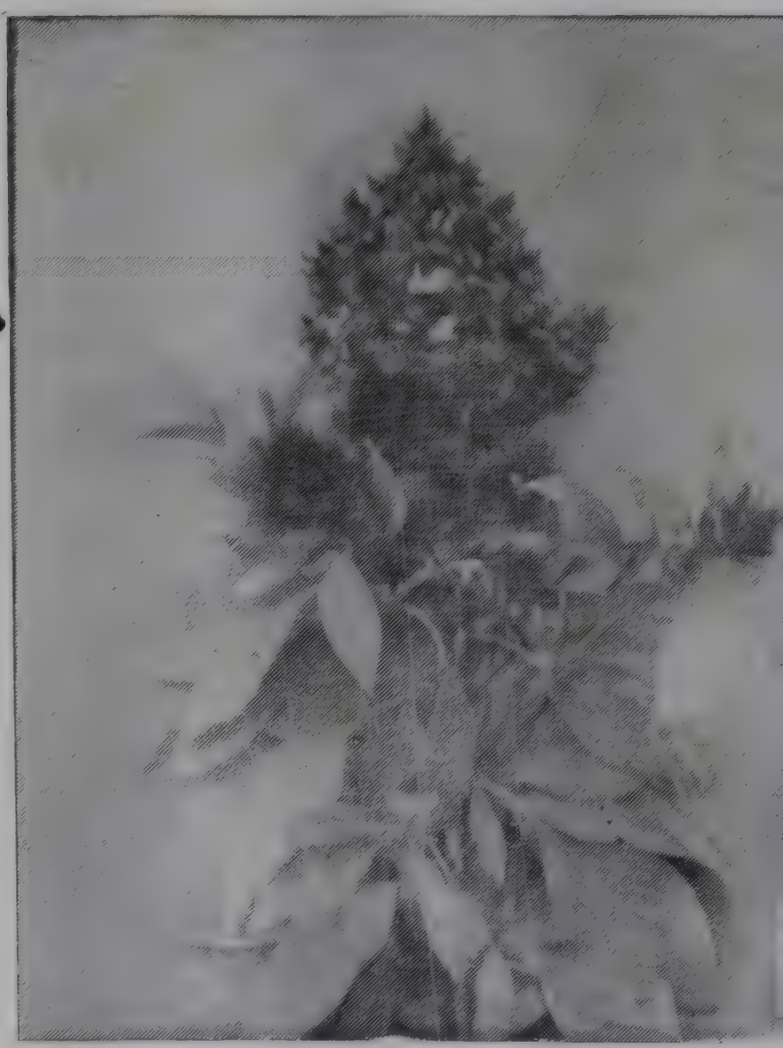
Samples and Date	% yeild	Ref.Index at 20°C	Opt. Rot.	Sp.fr. at at 24°C	Acid value
Flowers :					
March, 1952	0·42	1·5130	—5·3	0·9718	0·3
October, 1952	0·60*	..	..	..	..
November, 1952	0·54	1·526	—6·6	0·9899	1·24
February, 1953	0·31	1·528	—4·6	1·0025	5·8
Leaves :					
March, 1952	0·18	1·5235	—5·0	0·9941	0·57
July, 1952	0·21	1·5145 at 31 C	—5·4	1·004	1·4
October. 1952	0·34	1·520	—6·8	0·9868	2·25
November. 1952	0·24	1·5270	—5·6	0·9956	1·22
January, 1953	0·16	1·5130	—6·0	0·9676	0·83

* Just flowering. Only 50 g. flowers could be obtained.

PHOTOGRAPH No. 25

Spearmint leaves

PHOTOGRAPH No. 26



Dalna leaves and Flowers

PHOTOGRAPH No. 27

Dauna leaves and Flowers

PHOTOGRAPH No. 28

Eupatorium odaoratum

Samples and Date	% Ester as Methyl cinnamate	% alcohol as Linalool	% Methyl chavicol	Ocimene %	Unidentified %
Flowers :					
March, 1952	47·7	21·6	21·9	5·6	3·2
October, 1952	..	..	..	..	..
November, 1952	57·5	28·5	6·5	5·6	1·9
February, 1953	74·3	8·6	..	..	..
Leaves :					
March, 1952	59·6	14·5	22·5	2·8	0·6
July, 1952	51·8	20·3	22·9	1·2	3·8
October, 1952	54·1	33·8	10·2	1·2	0·7
November, 1952	63·6	12·0	16·4	4·5	3·5
January, 1953	43·6	29·8	24·3	0·8	1·5

The flower oil is more pleasant and fragrant than the leaf oil. The oils can be used for flavouring confectionary, baked goods and condiments like chillisauces, catechups, tomato paste and pickles, etc. It can also be employed in certain dental preparations. The oil can be used in soaps and as flavouring agent.

Camphor and camphor oil from Ocimum.

Camphor is one of the common remedies for a variety of purposes. It is used as rubefacient and mild counter-irritant.

India consumes large quantites of camphor in medicines and religious functions, all of which is imported from China, Japan, Formosa and U. S. A. The quantities imported have already been given.

Artificial camphor is made from L., pinene, which is amply found in foreign turpentine oils but as Indian turpentine oils are very deficient in L., pinene content, they cannot be used for camphor manufacture economically.

The other natural sources of camphor are camphor tree and camphor bearing ocimum leaves. The latter have been developed in the state by Dr. S. Krishna at Forest Research Institute, Dehra Dun.

To study its cultivation in the plains and to determine the yield per cent. in the leaves, ocimum kilimandscharicum ; as it is called, was cultivated in the local Agricultural College gardens and National Botanical gardens, Lucknow under the supervision of Prof. K. N. Kaul, who supplied us dried and green leaves for experimental work. It was found that it can be grown quite successfully even in very poor sandy soil without much irrigation and care. Semi-large scale experiments were made at Rudrapur (Rampur State). It was found that after every cutting, the plant gave out more shoots and formed into a big bush. The right spacing should be 2 feet, i.e., about 11,000 plants per acre.

The harvesting is done when the plant flowers profusely. There can be 3 cuttings per year. The plants after cutting are dried in the shade. The average yield of dried leaves per acre per year is 2,000 lbs.

The leaves contain the maximum amount of essential oil, next comes the flowers. For the distillation of leaves, a special type of box condenser was designed, with the help of Sri P. Appaji Rao because camphor being volatile escapes readily in the atmosphere, if the condenser water is slightly higher and if the temperature is low enough, the solid camphor will deposit in the condenser tubes and will thus block the passage of the distilling vapours.

[Diagram E]

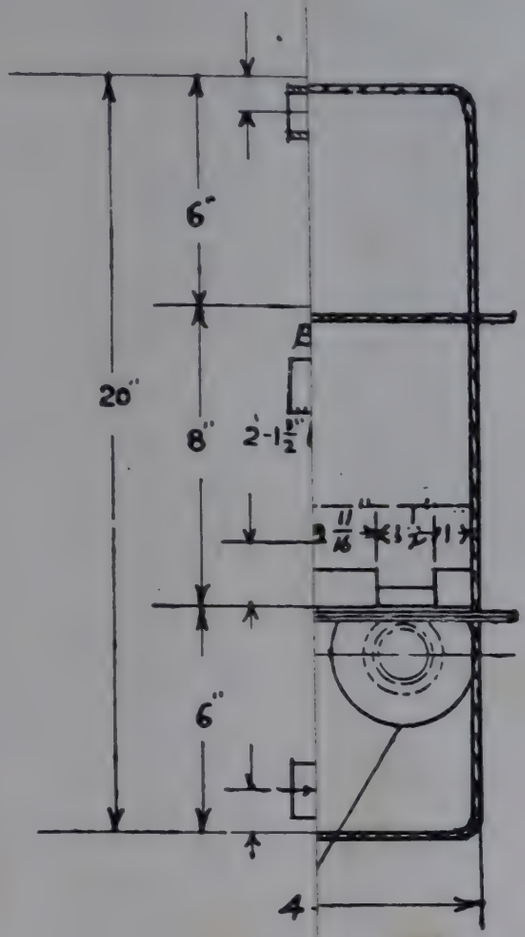
The yield of camphor and camphor oil varied from 2.8—3.6 per cent. on dry leaves on semi-commercial scale using steam for distillation. The dried flowers contained 1.8 per cent. camphor oil. The percentage of camphor in camphor and camphor oil mixture received after the distillation of leaves varies from 52—60 per cent. depending on the season. The mixture was filtered to separate crude camphor from camphor oil. Crude camphor was later on purified by sublimation. The loss on sublimation varied between 5—10 per cent. The purified camphor resembled natural camphor in its physical and chemical properties. The camphor oil was analysed and found to have the following properties.

TABLE No. 37

Parti culars	Analysis of Camphor Oil	
	Sample No. 1	Sample No. 2
Sp. gr. at 30°C	..	..
Ref. Index at 30°C.	1.4745	1.4750
Optical rotation	30°10′	28°14′
Acid Value	1.22	0.217
Ester Value	12.65	8.55
E. V. after acetylation	75.7	27.3
Aldehydes by bisulphite method	3.0 %	3.0 %
Camphor content	39.47 %	36.6 %
Phenols	Absent	Absent.
Solubility in 80 % alcohol	Freely soluble.	Freely soluble.

The camphor content was determined by converting it into semicarbazone.

The oil was fractionated under reduced pressure and the individual fractions were analysed.



ED OFF AS SHOWN

A major portion of the camphor present in the oil can be isolated from the oil by cooling it in ice.

A sample of camphor oil from which camphor was isolated by cooling was sent to Malaria Institute, New Delhi to assess its insecticidal properties. It was found to possess 30 per cent. insecticiadal properties, in comparison to Pyrethrum extract for mosquitoes, etc.

The oil contains terpenes, sesquiterpenes and linalool.

Oil from Eupatorium odoratum.—This common hedge plant belongs to compositae family. There are 600 species of this plant chiefly found in Mexico, West Indies and tropical South Africa. Some of the varieties have been grown in temperate and tropical climates. It requires a rich loamy soil and frequent irrigation. E. Ayaparia grown in India has been used in cholera, snakebite, and is diphoretic and a stimulant tonic. The leaves of E. Odoratum contain an essential oil which was extracted by steam distillation in April and July. The oil is pale yellow in colour and had the following characteristics.

The yield of the oil was less in Rains than in Summer.

[Photograph no. 28]

TABLE No. 38

Parti culars	Oil from—	
	April cutting	July cutting
Sp. gr. at 30·C	0.9175	0.9054
Ref. Index at 30·C	1.506	1.499
Opt. Rot.	—17.0	+11.6
A. V.	1.56	1.48
E. V.	23.23	13.88
E. V. after acetylation	56.53	46.71
Aldehydes by Sod. bisulphite method	12 %	5 %
Phenol contents (Caustic soda method)	10 %	6 %
Solubility in alcohol	Equal volumes of 95 per cent. alcohol.	
% yield of oil	0·08 %	..

The chemical composition is being examined.

Oil from Mango Leaves (Mangifera Indica):

Mango tree has been well known on account of its delicious fruits since very long time. It is called "Amra", 'Chuta', in Sanskrit, "Am" in Hindi, Gujrati and Bengali, "Amba" in Marathi, "Thayet" in Bombay, "Mamidi" in Telegu, "Mamaram" in Tamil, "Mampalain" in Malaya.

The tree is indigenous to India and is cultivated in many varieties throughout the tropical countries. Its fruit is diaphoretic, astringent and refrigerant; the ripe one is slightly laxative and diuretic, nourishing and invigorating. The bark is astringent and tonic. In cases of Asthma, Diarrohoea, chronic Dysentry, Haematemesis and menorrhagia, leucorrhoea, bleeding piles round worms etc., powedered seed or kernel is given. A decoction of leaves is useful in aphonia and the tender leaves after drying and powdering are useful in Diabetes. The ashes of the leaves are popular remedy for burns and scalds. Practically all parts of the plant i.e., fruits, flowers, leaves contain some essential oil.

Experiments were carried out at the Institute to extract the essential oil from the leaves of "desi" Mango tree. The percentage yield of oil obtained was . The oil has the following characteristics.

It is a thick and viscous liquid having dark red colour. Its sp. gravity @32.0 degrees centigrade is 1.002 and Refractive Index at 31.5 degrees centigrade is 1.505. The oil is soluble with turbidity in 1 : 5 vols. of 80 per cent. alcohol.

Blackberry Leaves Oil :

Eugiena Jambolana belongs to the family Myrtaceae. It is called Nilaphala, Rajphala of Jambul in Sanskrit, Jamun in Hindi, Kalajam in Bengali and Blackberry in English. The tree is found throughout the plains of India. It is valued on account of its fruits which are said to possess stomachic, carminative and diuretic properties.

The leaves of the tree possess an aggreeable odour due to the presence of an essential oil which has not yet been worked out. The oil was, therefore, extracted by steam distillation with the help of solvents and examined. It was observed that the percentage of oil in leaves in winter is more than that in rainy reason varying from 0.013 to 0.02 per cent. The properties of oil are as follows :

TABLE No. 39

Colour	Dark brown with an agreeable odour.
Specific gravity 30°/30°C.	0·9264
Refractive Index at 30° C.	1·4962
Optical rotation	—12°
Solubility in 90 % alcohol	1 in 5 vols. with slight turbidity.
Acid value	5·85
Ester value	44·52
E. V. after acetylation	82·72
Ketone percentage by bisulphite methods ..	4·0 %

The oil is dark brown in colour and possesses an agreeable odour. It can be used in soap perfumes and cosmetics.

OILS FROM ROOTS AND TUBERS

(1) *Oil of cyperiol (Cyperus Scariosus)*:

It belongs to N. O. Cyperacea and is known in Sanskrit as Nagar Musfaka and in Hindi as Nagar Moth. It occurs in damp places of Bengal, Pegu, U. P., Southern parts of India and common in Sunderban. The plant produces deep brown tubers with aromatic odour, which are used for medicinal purposes. The oil extracted from it is used as a hair tonic.

The oil was distilled from nagarmotha tubers received from Kanpur market and Dholpur at H. B. Technological Institute and examined. The analysis of a sample of nagarmotha oil (Cyperiol) obtained from Messrs. Manuan Lal Ram Narain, Kanauj is also given in the table below:

TABLE No. 40

Particulars	Messrs. Manaunlal Ram Narain	Dholpur sample	Kanpur Market	
			Black variety	Red variety
% yield of oil in tubers	0·31%	0·29%	0·29%	0·35%
Sp. gr. at 30°C.	0·9898	1·0130	0·9740	0·9937
Ref. Index at 30° C.	1·5130	1·5146	1·5084	1·5104
Opt. rotation	—9·14	—10	Too dark.	—6·5
Acid value	5·36	31·4	6·99	7·56
Saponification value	14·87	20·59	21·34	21·31
Ester Value after acetylation ..	108·0	127·9	82·2	92·40
Ketones as $C_{15}H_{22}O$ by hydroxylamnie hydrochloride method. ..	..	68·48%	35·92 %	52·0%

Vetiver Oil:

Vetiver (Vetiveria Zizanioides) belongs to N. O. Gramineae and is known in India as Khas-Khas or Khas and in Java it is called Akar wangi. It grows wild on the plains and slopes of mountains in N. India, Ceylon and Malaya while it is cultivated in Java, Reunion, Haiti, Guatemala, Mexico and Brazil.

In India it grows wild particularly on the banks of rivers, canals and marshy lands in Uttar Pradesh, Punjab, Bharatpur, Baroda, Hyderabad, Mysore, Assam, Bihar, Orissa etc., while in South India it is cultivated in Malabar, Tuticorin, South Tranvancore and some parts of East Godawari.

The roots of the plant contain an essential oil having an agreeable sweet odour. They are used for making aromatic mats and screens during summer season, because these when sprinkled with cold water, impart a fine refreshing aroma and cool the surrounding atmosphere.

[Photograph 29]

Khas grows in any soil, though loamy cum sandy soil is most suitable. In India, the harvesting of roots commences from November to February. The length of the roots grown in India varies from 4″ to 14″ depending on the age of the plants. Thicker roots produce more oil than thinner ones. The thickness of the roots varies from 1.0 to 3.0 mm. The digging of roots commences from early morning till dark and one labourer can dig 15–20 seers of roots per day. The wages vary from Rs.4 to Rs.6 per maund of roots.

In southern Indian 0.5 to 1.0 ton of khas roots are obtained per acre. Systematic experiments have shown that the oil content increases progressively upto 21 months (yield 0.87 per cent.), after the 10th month it is 0.1 per cent., at 15th month–0.56 per cent. and at 17th month–0.79 per cent. It is not economical to harvest the roots before a minimum maturity of 15 months. An interval of 15–18 months is considered to be the optimum maturity period.

The roots vary in colour from light yellow or yellowish brown to reddish. If the roots are very light or almost white in colour they contain very little oil. The following are the characteristics of good quality khas roots.

(*a*) It should expose a hard surface when the skin is peeled off.

(*b*) It should not break on bending.

(*c*) It should be long, thick and hairy.

(*d*) It should be bitter in taste when chewed and the more bitter the root, the higher the oil content.

The distillation of khas roots in beset with considerable difficulties due to the viscid nature of the oil, low volatility and high boiling constituents. The separation of the oil from water is also troublesome owing to its specific gravity approximating water.

The yield of oil depends on the quality and maturity of roots and also on soil and climatic conditions. In North India, the yield of oil is calculated on air dried khas roots containing dust and root knots, but in Indonesia and other countries, the roots are supplied after proper washing and without root knots. In South India however, the roots are marketed after washing but with

root knots. The yield of oil in root knots and roots have been determined separately and are given in the following table :

TABLE No. 41

Place	% Root Stems	% Root knots	% Dust	% Oil in stems	% Oil in root knots	Remarks
1. Daulatgarh	35·9	61·4	2·6	0·63	0·051	Flowering
2. Naswaria	38·8	52·9	8·3	0·74	..	Do.
3. Rupwas	34·8	58·7	6·38	0·87	0·1	Do.
4. Bharatpur	..	..	..	1·25	0·06	Non-flowering variety.
5. Math	32·0	48·0	20·0	0·45	0·16	Flowering
6. Mandhna	14·0	50·0	36·0	0·73	..	Do.
8. Musanagar	19·2	24·8	56·0	0·42	0·076	Do.
8. Biswan	24·9	57·3	17·7	0·85	0·18	Do.
9. Travancore	58·0	42·0	..	2·07	0.22	Reddish no dust.
10. Ram Nagar	..	..	..	0·25	..	Received without root knots and dust.
11. Kanpur	76·0	2·40	..	0·82	..	Without dust
12. Indonesia	..	..	..	4·01	..	..
13. Uttari Pura (Kanpur) ..	..	..	..	0·51	..	..

It may be observed that north Indian Vetiver roots yield much less quantity of oil than those from South India. The cultivation of S. Indian khas roots, therefore, has been taken up in our fields.

The distillation of khas roots is generally done in the country stills at the centres. There are only two factories in Uttar Pradesh which manufacture khas oil using steam. The oil extracted by steam distillation is about 15—25 per cent. more than that by country stills. The time of distillation varies from

12–24 hours. The table below gives the percentage yield of oil obtained in various countries :

TABLE No. 42

Country	Average yield of oil	Maximum yield
1. Java	0·7—1·0 % (cottage industry) .. 1·5—2·0 % (modern stills) ..	3·0%
2. Reunion	0·6—1·2 % (Primitive stills) .. 1·5—2·0 % (modern stills) ..	2·0%
3. Brazil	1·5—2·0 % (modern method) ..	..
4. Europe	0·4—1·0 %	..
5. Haiti	1·5—2·0 % (modern stills) ..	..
6. India, Travancore ..	0·5—1·7 %	2·0%
Malabar ..	0·3 %	..
N. India ..	0·1—0·3 %	1·2%
7. Belgiam Congo ..	1·1—2·1 %	2·87%
8. Jamaica	1·2—3·3 %	4.0% using steam
9. Phillipines	0·92 %	..

The following table gives the results of the analysis of samples of vetiver oils prepared at different centres in Uttar Pradesh and Bharatpur together with one of Travancore.

TABLE No. 43

Particulars	Sultanpur	Biswan	Bharatpur	Math	Kanpur	Musanagar	Travancore
1. Sp.gr. at 30°C	0·9951	0·9848	1·0051	0·9970	1·0467	1·0476	0·9857
2. Ref. Index	1·5145	1·5110	1·5140	1·5155	1·5188	1·5170	1·5190
3. Opt. rot. ..	—88·4	—91·9	—89·5	—120·8	—74·2	..	+ 27·3
4. Solubility in 80 % alcohol.	1-2 vols.	1-2 vols.	1-2 vols.	1-2 vols.	1-2 vols.	1-2 vols.	1-3 vols.
5. Acid value	8·6	5·5	8·5	9·0	16·8	40·8	19·8
7. Ester Value	19·4	14·2	24·6	18·6	16·8	38·19	21·08
7. E. V. after acetylation.	163·6	175·2	197·7	196·1	167·4	174·69	173·8
8. Free alcohols as vetiverol.	63·54%	71·93%	78·10%	80·28%	66·65%	59·74%	67·5%
9. Combined alcohol as vetiverol.	7·77%	5·62%	9·80%	7·57%	6·70%	15·45%	8·44%
10. Total alcohols as vetiverol.	71·31%	77·55%	87·90%	87·85%	73·35%	75·19%	75·94%

It may be seen from the above table that the optical rotation in Travancore (S. India) khas oils is positive (dextro-rotatory) while the oils from N. India have laevo-rotation. It may, therefore, be concluded that North and South Indian khas oils differ from each other and that the latter resembles Indonesian vetiver oil in vetiverol content, which is much lower than that in North Indian samples. Owing to these differences great difficulties are being experienced in drawing the specifications and standardisation of this oil.

IV. Oils from some Essential oil bearing seeds

Oil from Dill Seeds (Anethum Sowa):

It is called satpushpi or Misariya in Sanskrit, Sowa or soya in Hindi, Bengali and Punjabi, Satakuppi in Tamil, Surva in Gujrati ; Shepu in Marathi. The seeds are often used as a carminative, stomachic, stimulent and diuretic. The distilled water of fruits its much used in flatulence, hiccough, colic and abdominal pains of children and adults.

The leaves are widely used as a flavouring agent in vegetables, meat and curries. Dill herb oil is employed for flavouring of soups and sauces, etc. Dill vinegar forms house hold condiment. [Photograph 30]

The seeds are sown in winter and the crop is harvested in April. One acre of land yields 500–700 lbs. of dill seeds.

To extract the essential oil, the seeds are crushed and then distilled by steam for a period of 10–12 hours. The yield of oil varies form 2.3 to 3.0 per cent. The oil is pale yellow in colour.

The dill herb oil is prepared from the fresh green herb by distillation with steam for 8–10 hours. The percentage yield of oil is from 0.4–0.6 per cent. The oil is brownish yellow in colour. The properties of oils from dill seeds and herb are given below. It may be noted that the herb oil contains less carvone than that from seeds.

TABLE No. 44

Particulars	Dill Seed oil	Dill herb oil
1. Sp. Gr. at 30°C.	0·9341	0·9241
2. Opt. rot.	+ 54°	+71·8
3. Ref. Index at 30°C.	1·4854	1·4864
4. Acid Value	1·2	1·96
5. Ester Value	37·7	43·25
6. E. V. after acetylation	56·3	90·45
7. % Carvone	41·7%	13·55%
8. Phenols		5·6 %

As Indian dill seed oil contains less carvone and does not satisfy the B. P. specifications, according to which the oil should contain not less than 43% and not more than 63 per cent. carvone, it is not used in pharmaceutical preparations. To meet the specifications, the Indian dill seed oil was fractionated such that 10 per cent. fraction in the beginning and 20 per cent. fraction at the end was rejected, the remaining oil contained about 50 per cent. carvone, which lies within B. P. specifications. The problem was solved for a party in the state.

The seed oil contains limonene, carvone and dillopiol as the main constituents while the herboil contains d L phellandrene and carvone.

Ajowain oil (Phycotis Ajowan) oil :

[Photograph 31]

It is largely cultivated in U. P., Bihar, Madhya Bharat, Punjab and Bengal etc. in India.

It is called Ajmada, yavanika in Sanskrit, Jowan in Bengali, Ajowain in Junjabi, Jawind in Kashmir, Vova in Bombay, Yavan in Gujrati, Omum in Famil, Omainu in Telgu and Jamhun in Burmese.

The seeds are useful in flatulence, colic, atonic, dyspepsia, Diarrhoea. Cholera, Hysteria and spasmodic affections, of the bowels. Externally it is applied to relieve rheumatic and neuralgic pains. The seeds made hot, are used as a dry fomentation to the chest in asthama and to the hands and feet in cholera and fainting. It checks chronic discharges from bronchites. The leaves are used as a vermicide.

The seeds contain an essential oil which is rich in thymol. Large quantities of seeds are exported to foreign countries. The seeds are sown in November and plants are harvested in May. The seeds on distillation yield 2.5—4.0 per cent. oil. The exhausted seeds contain 10-25 per cent. fixed oil.

The oil was commercially manufactured at Rao in Indore upto the second World war, but now it is not in operation. Small quantities of oil are now being made at Kanauj. The production of the oil has decreased due to the synthetic preparation of thymol.

The seeds cultivated in our fields yielded 2.7 per cent. oil. The oil had the following properties. Ajowain herb oil was also prepared and examined. The yield of oil was 1.52 per cent.

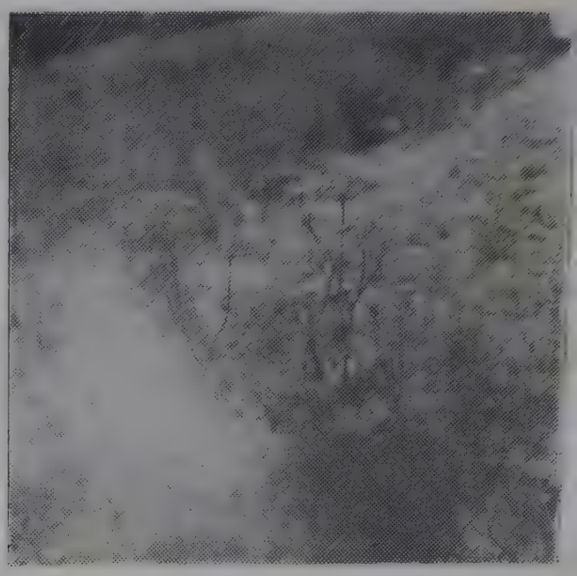
TABLE No. 45

Particulars	Seed oil from		
	H.B.T.I.	Market	Herb Oil
1. Sp. gr. at 30°C.	0·9265	0·9222	0·8975
2. Ref. Index at 30° C.	..	..	..
3. Opt. Rot.	+1.0	+4·0	+8·0
4. Acid value	3·7	1·76	0·9
5. Ester value	10·6	8·82	5·6
6. % phenols by caustic soda method ..	57%	38%	25.0 %
7. Thymol %	47·0%	..	23.9%
8. Solubility in 80% alcohol	1·4 vol.	2·4 vols.	8·5 vols.

PHOTOGRAPH No. 29

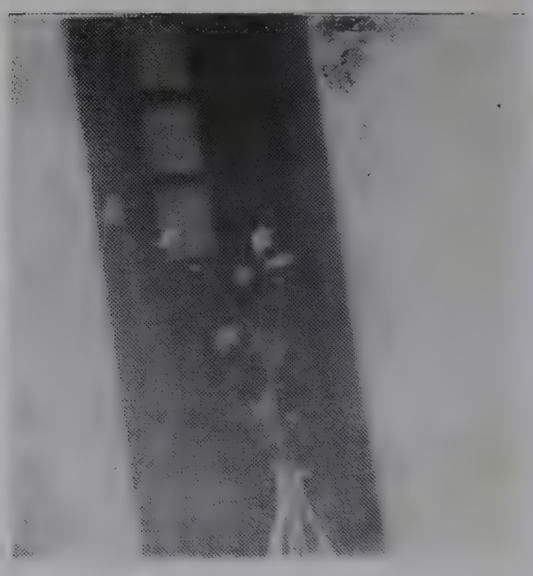
Khas Plant

PHOTOGRAPH No. 30



Sowa

PHOTOGRAPH No. 31



Ajowan

The seed oil was found to contain Y terpinene, dipentene and paracymene along with thymol and carvecrol.

Manufacture of Agarbatts

The burning of aromatic plants and their products (resenoids, etc.), has been practised since long in Eastern countries. The burning of sandal wood powder, Dhup and agar, etc., has become a common feature in Indian houses these days. The Chinese use sandal wood powder as incense. Agar wood is very costly and beyond the capacity of an average person. Therefore thin bamboo sticks coated with a paste consisting of powders of aromatic woods, resenoids and spices and essential oils and called "agarbattis", are generally used in its place. Their production is chiefly carried out in Mysore, Bangalore, Ponna, and a few other places as a Cottage Industry. Besides home consumption, they are exported to Africa, Middle-East and South-East Countries.

There are, in the market, several kinds of agarbattis which differ in the aroma, burning time and thickness of coating, etc., depending on the manufacturers.

Owing to rigid trade secrets by the manufacturers the industry is monopolised by a few parties. As all the raw materials used in their manufacture are available in the country and the industry is not well developed in the State, experiments were made to prepare them.

A number of compositions were made using finely powdered exhausted sandal wood, as the base to which different resenoids and essential oil blends were added in certain proportions. Gum acacia was used as an adhesive. To start wtih, the essential oil blends for agarbatti may be purchased from the market. The following formula was found satisfactory :

Sandal wood powder	12 parts
Gumbenozin	1 part
Gum Acacia	1 part
Gugul	1 part
Perfume	1—1·5 parts.

The bamboo sticks coated 6 inches in length with this composition can burn about half an hour.

The industry is very profitable and can be carried out at spare time or by women. The cost of production works out to be annas eight to annas ten per gross of sticks.

TO MAKE THE BROCHURE MORE INFORMATIVE

It is desirable to describe in brief, those oils as well, which are manufactured in the country on a large or small scale, viz., sandal wood oil, Eucalyptus oil, geranium and cinnamon oils, etc.

Cinnamon Oil :

It is prepared from the barks and leaves of Cinnamon Zeylaricum. The largest producer of cinnamon oil is Ceylon. The oil is distilled in Malabar, South Kanara, Bangalore, Angarkandy State near Tellicherry. Only pungent and bitter leaves are distilled for about 16 hours. The oil is heavier and therefore it sinks to the bottom. The yield of oil is 0.5 per cent. to 0.75 per cent.

Cinnamon leaf oil is a brown pungent liquid with a camphoraceous odour. The properties are given below. It is used in flavouring confectionary and is a common adulterant for cinnamon bark oil. Eugenol is isolated from the oil easily and is used for the preparation of vanillin. It is used in rheumatism. The annual production of the oil in North Mangalore is about 3,600 pounds, and in North Kanara 1,00,000 pounds per annum. India imports cinnamon leaf and bark oils from Ceylon. The yield of oil from bark is 0.5 to 1.0 per cent. and it is very rich in aldehyde content.

The properties of the cinnamon leaf and bark oils are given below :

TABLE No. 46

Particulars	Cinnamon Leaf Oil from		Cinnamon bark oil from Ceylon
	India	Ceylon	
Sp. gr. at 30°C	1·0443—1·0620	1·044—1·066	1·023—1·040
Ref. Index	1·5223—1·5350	1·530—1·540	1·581—1·591
Opt. rotation	..	—1 to +3	..
Acid Value	14·0—15·7	..	..
Ester Value	4·7—16·7	..	..
Eugenol %	70—85·5	70—95	4—10
Cinnamic Aldehyde	..	..	65—76%
Solubility in 70% alcohol	..	..	..

Cinnamon bark oil is a valuable flavouring ingredient used widely in all kinds of confectionaries baked goods, candies, soft drinks and table sauces, etc.

Eucalyptus Oil :

The genus Eucalyptus includes over 500 species a major of which is used for essential oils. Three types of oils are generally used. (1) Medicinal oils or cineole oil ; (2) Industrial oil ; (3) Perfumery oil (Phellandrene oil).

Australia is the largest producer of Eucalyptus oils. India imports large quantities of the oil from Australia for her requirement.

In India, Eucalyptus oil is obtained by the distillation of leaves of E. Globulous which grows on Nilgiris. Annamalai and hills. Mature leaves from trees, 15 years of age and above are preferred. They are dried for 3 days in shade and then distilled. The crude oil is refined by redistillation after adding caustic potash. They yieldd varies from 0.9 to 1.2 per cent.

The oil is a colourless to pale yellow liquid with a characteristic odour. The oil is used mainly for medicinal purposes. It is used as an antiseptic and deodorant in the treatment of chronic bronchitis asthma, catarrhal colds and hookworm. The estimated acreage under E. Globulus in Nilgiris is about 2,000 acres. The characteristics of Nilgiris oils are as follows :

TABLE No. 47

Particulars	No, 1	No. 2	Australian	B. P. Specifications
Yield %	.. 0·9—1·2 %	1·18%	0·92%	..
Sp. Gr.	.. 0·902 at 1 30°C.	0·9065—0·9155 at at 19°C.	0·913 at 15°C.	0·904—0·924 at 20°C.
Ref. Index at 20°C.	1·4608	1·4630—1·4666	1·4613 ..	1·458—1·4670
Opt. rotation	+9·68	+5·28 9·39	+8·4	—5 to +5
Acid value	6·3	0·14—0·18	..	..
Ester value	31·2	8·8—19-8	..	..
S. V. after acetylation	92·2	17—21·7	..	..
Cineolecontent	62·2%	56·0%	57%	70%
Solubility in 70% alcohol	Insoluble in 10 vols.	Insoluble	Soluble in 1·5 vols.	Soluble in 5 vols.

Geranium Oil :

The only true geranium species from which essential oil is derived is G. Macrorrhizum L., which grows wild in Bulgaria and Balkan countries. The oil distilled from it is employed for the adulteration of rose oil. The commercial oil of geranium is derived from several species, varieties and strains of Pelargonium and is grown in Reunion, Algeria, Morocco, France, Spain, Belgian-Congo and East Africa.

Owing to its agreeable and pronounced strong rose like odour, oil of geranium is one of the most important items in perfumery. It blends well with all kinds of scents and is widely used in scenting of soaps.

Pelargonium Graveolens grows wild in Nilgiris. The cultivation of the plant on a large scale has been taken up at yerc and hills near Salem from cuttings of P. Odoratissima from Reunion islands. The oil is being produced there on a small scale. The yield is reported to be 8 pounds of oil per acre.

The leaves are collected in Sunshine when they begin to their yellow and their odour resembles with that of roses. The oil collected by distillation is green in colour. The principal constituents of the oil are geraniol, citronellol, Phenyl ethyl alcohol and linalool, etc.

The properties of Indian geranium oil are given below :

TABLE No. 48

Particulars	Oil foreign	Oil Indian		
		Yercand	Naujangud	Nilgiri
1. General appearance	Clear, light yellow to greenish	Yellowish green to greenish.	Clear Yellowish green.	Clear yellowish green.
2. Sp. gr. 15°/15°	0·8906—0·8947	0·8998—0·9079	0·8946	0·8880
3. Ref. Index at 20°C	1·4644—1·4674	1·4638—1·4708	1·4688	1·4600
4. Temp. of solubility in 3 parts of 70 p. c. (vol.) alcohol.	20° and below	20° and below	20° and below	20° and below
5. Acid value ..	3·65—16·03	7·9—10·7	2·6	..
6. % Ester as geranyl	18·96—31·75	18·98—22·26	21·0	40·10
7. Fleurescence in ultra violet light.	Greenish to bluish.	Greenish to bluish.	Bluish.	Bluish.

The production of Geranium oil in India is about 1,500 pounds per acre.

Linaloe Oil

Bursera Delpichiana or linaloe tree is a native of Mexico. In India its plantation was started in Tatguni, 11 miles from Bangalore about 30 years ago, the area of cultivation is being expanded every year. Unlike the Mexican practice, the oil is obtained exclusively from the outer husks of berries. The yield of oil is 1.8 per cent. as compared to 2.5 to 30 per cent. obtained from the wood in Mexico. The oil is called Mysore Linaloe oil. The ripe berries are collected when they fall to the ground. After drying and removing the shell, the berries are distilled by steam.

Mysore linaloe oil is a light coloured mobile liquid. It resembles Bois de Rose.

It can be used as fixative in perfuming lily, lavender, cananga and sweat pea soaps. It can also be employed in transparent soaps. The following table gives the characteristics of Mysore linaloe oil. For the sake of comparision the properties of Mexican Linaloe oil are also given.

TABLE No. 49

Characteristics of Linaloe Oils

Particulars	Mysore oil	Mexican oil	
		From wood	From seeds
Sp. gr. at 15°C ..	0·8885—0·8911	0·883—0·899	0·885—0·888
Opt. rotation ..	—0°18′+2°18′	—5°25′—13°8′	+2·4′to+3·10′
Refractive Index at 20°C. ..	1·4600—1·4623 (25·C)	1·4587—1·4612	1·4641—1·4650
Acid value ..	..	0·8—2·7	Upto 3·1
Ester content as linalylacetate%.	31·4—44·1	14—27·1 ..	13·9—18·6
Solubility at 20°C ..	Sol. in 1·5—2·5 vols. of 70% alcohol.	Sol. in 4·5 vols. and more of 60% alcohol.	Sol. in 5 vols. and more of60% alcohol.

The main constituent of Mexican Linaloe wood oil is Linalool (60-75 per cent.) along with geraniol, terpeniol, methyl-heptenone nerol and sesquiterpenes. Mysore oil contains mainly linalyl acetate (33—44 per cent.) along with small quantities of methyl heptenone, Linalol (47.7 per cent.) and sesquiterpenes etc. It is much preferred by the perfumers on account of its content. The average annual production of oil from Tatkumi State is 6,000—7,000 lbs.

The leaves of linaloe trees yield an oil (0.15—0.25 per cent.). It possesses a sweet odour and is very rich in linalyl acetate (67.67 per cent.), therefore it is much preferred by perfumers.

Patchouli Oil.

It is obtained from Pogostemon potchouli which is cultivated in Malaya, Sumatra, Java, Madagaskar and Reunion etc. About 90 per cent. of the world's output is supplied from North Sumatra. Efforts have been made to grow these plants in India for the last 3-4 years at Bangalore. The seeds were imported from Singapore and Johore. A good quality of oil was prepared in 1953 by Rao Sahib B. S. Nirody at Indian Institute of Science, Bangalore from the cultivated plants there.

The leaves after cuttings are dried and matured without permitting fermentation to occur and the material for distillation should be freed from foreign matter and stalks.

The distillation of leaves is carried out by steam. The yield and quality of oil are improved by prolonginig the distillation. The more valuable components of the oil are present in high boiling fractions. The aged oils have finer aroma than fresh ones. The yield of oil varies from 2.5–3.0 per cent. on the weight of dried leaves. The properties of the oil prepared at Bangalore from the plants grown—they are given below, for the sake of comparison. The characteristics of the oils from Indonesia and Singapore are also given in the table.

Characteristics of Patchouli Oil

TABLE No. 50

Particulars	Bangalore	Indonesia			Malaya		
		Tjalang	Tapa Toen	Menlobole	Johore	Singapore	Signapore (a)
Yield % ..	2·22	1·93	2·22	3·66	4·04	3·73	0·47
Refractive Index at 22° C.	1·5201	1·5110	1·5097	1·5087	1·5082	1·5106	1·5116
Sp. gr. at 15° C	1·0011	0·9941	0·9858	0·9817	0·9707	0·9877	1·0097
Opt. rotation	—22·5°	—35°	—48°	—48°	—38°	—48·5°	—48°
Acid value ..	3·15	2·25	2·88	2·76	1·85	2·88	28·40
Ester value ..	6·11	6·75	2·37	3·47	3·12	2·64	4·05
Acetyl value ..	93·81	24·80	23·25	18·94	17·60	20·83	49·90

Patchouli oil is one of the best fixative for heavy type of perfumes. It blends well with Palmarosa, clove, khus, cassia and other oils. It is used in a number of blends of soap and other cosmetics etc.

Sandal Wood Oil.

Indian Sandalwood oil commonly known as East Indian Sandalwood is obtained from the roots and heartwood of Santalum Album. This tree occurs in Coorg, Madras and Mysore. It is also found in Malaya Archipelago in "Timor" Island. About 2,000 tons of wood is obtained from Mysore alone every year. Mysore controls about 7|8 of the world's production of sandal wood oil. The trees are cut which are at least 30 years old and have a circuference of at least 15".

The wood is chipped and disintegrated into course powder before distillation. The average yield of oil varies 105–110 lbs. per ton of wood on 4.5–6.5 per cent. on the weight of woods. The roots yield oil up to 10 per cent. while hard and soft wood yield only 2.0 per cent. oil.

Besides the Government Sandal Oil Factory at Mysore, there are 2 small distilleries in Kuppam in Madras State ; one at Bombay, one at Mettur and two at Kannauj (U. P.), one at Faizabad, one at Kanpur and one at Calient.

The distillation is conducted for 48—72 hours with low pressure steam (20—40 lbs. per sq. inch).

The oil is yellowish in colour, with a characteristic heavy sweet lasting odour. It contains at least 90 per cent. santalol. It is used in medicine and in perfumery. It has excellent fixative properties and most compositions contain sandalwood oil. Almost 90 per cent oil is consumed in Soap, perfumery and Cosmetics.

The annual production of Sandal wood in India is about 1,80,000 lbs. out of which about 1,20,000 lbs. is exported. The properties of sandalwood oil are given below :

Characteristics of Sandal Wood Oil

TABLE No. 51

	Mettur	Mysore	I. S. I. Standards
1. Sp. gr.	0·928 at 25°	0·9782 at 15·5°	0·962—0·976 at 30°C
2. Ref. Index	1·5058 at 25°	1·5068 at 20° C	1·4990—1·5060 at 30° C.
3. Opt. rot.	—17°·1′ (25° C)	—17°1′ (20° C)	—15° to —20°
4. Total Sentalol %	96·0	..	..
5. Free santalol %	91·0	91·2	not less than 90
6. Ester of santalol %	5·0	2·5	2% minimum
7. Solubility	Sol. in 5—12 vols. of 70% alcohol.	Sol. in 5 vols. of 70% alcohol.	Soluble in 5 Vols. of 90% alcohol.

Preparation of synthetic aromatic chemicals and natural isolates

Some natural isolates e.g. geranial from palmarosa oil, citral from lemongrass oil have been prepared in the laboratory. The methods of their isolation are given below :

Geraniol from palmarosa oil—Geraniol is extensively used in the blending of perfumes and is an essential constituent of the rose perfume. It is prepared from palmarosa oil, which contains 75—90 per cent. of geraniol. For its isolation, equal quantities of palmarosa oil and freshly fused and powdered calcium chloride were ground thoroughly in a mortar. The mixture generated heat, but it was kept cool (below 5 degrees C.) by surrounding the reaction vessel in ice. The unreacted oil was decanted from the mixture, the solid compound was pulverised, moistened with petroleum ether and filtered on a Buchner funnel. The solid was washed 4—6 times with petroleum ether in order to free it

completely from the unreacted oil which dissolved in ether and passed in the filtrate. The calciogeraniol compound so obtained was kept over night and then decomposed with the cold water to separate geraniol which floated on the top. The separated oil was rapidly washed with lukewarm water and finally distilled by steam.

The percentage recovery went upto 80 per cent, the purity of geraniol being 95 per cent. The percentage recovery depends upon the size of the particles of powdered calcium chloride and the percentage of moisture present in it. Further the temperature of the mixture should be maintained below 5 degee C. when calcium chloride is ground with the oil to get the maximum yield.

Citral from lemongrass oil.—Citral is an important reagent in the preparation of ionone from which violet perfumes are prepared. More recently it has been employed for the preparation of vitamin A and numerous other polyene compounds. India exports huge quantities (tons) of lemongrass oil containing at least 75 per cent. citral. Attempts were herefore made to isolate citral from lemongrass oil and prepare ionones. The most common economical method is the fractional distillation of lemongrass oil under reduced pressure, fraction containing 92–95 per cent. citral can be easily obtained in this way and this can be satisfactorily used for flavouring perfumary or manufacture of ionones. Care should be taken that the citral so prepared is free from the characteristic odour of lemongrass oil which is primarily due to the presence of methyl heptanone because it will effect the perfume. If a purer product is required, chemical methods of purification have to be used. Citral forms an additive compound with sodium sulphite or sodium bisulphite from which it can be easily liberated. The treatment with sodium bisulphite, however, tends to form stable sulfonates from which it is not possible to regenerate citral ; sodium sulphite is generally employed.

350 g. of crystalline sodium sulphite 125 g. of sodium bicarbonate and 1 litre water were mixed together, cooled to 5–10 degree C. and 100 g. (Commercial) citral added. The mixture is mechanically stirred for 2–4 hours. The presence of air is avoided as far as possible while stirring is done.

The unreacted oil was extracted with ether and separated. The mixture was once again thoroughly extracted with ether so that all the unreacted oil is removed.

Citral was liberated from the mixture by the addition of 10 per cent. caustic soda solution and ether, and shaking the mixture vigorously till all the oil precipitated. The traces of alkali in the ether extract were neutralized with dilute solution of tartaric acid. It was then washed till neutral with distilled water. The solution from which citral had been liberated was once again treated with ether and 10 per cent. caustic soda solution with stirring so that any citral left in it might be set free. The ether extract was washed with diluted tartaric acid solution and washed till neutral. The two ether extracts were combined and the ether distilled off. An yield of 70–80 per cent. was obtained by this method, the citral isolated was almost pure i.e. 99.5 per cent. purity.

Preparation of Ionones. —It is one of the most important ketones for the preparation of synthetic violet odours.

When citral is condensed with acetone in presence of an alkali, an isomer of ionones called pseudoionone is obtained. If the pseudoionone is heated with dilute sulphuric acid and a little glycerine, it is converted into the ionone.

The commercial ketone ionone is a mixture of two isomeric ketones L and B ionones. It has a characteristic violet odour and at the same time recalls the vineblossom.

L ionone is prepared from the commercial product by converting it into the crystalline oxime which is recrystallised from petroleum ether and regenerated by dilute sulphuric acid.

B ionone is obtained from the commercial mixture by means of the semicarzazone which crystallizes more readily than the corresponding derivative of L ionone and can be thus separated.

The chief constituent of the commercial ionone is L ionone. A number of patents have been taken on the preparation of ionones. There are other methods, for the separation of L and B ionones. The hydrosulphonic compound of L ionone crystallise more rapidly than that of B ionone, where as the corresponding compound of B ionone is more readily decomposed by steam. If sodium chloride is added to a hot solution of the hydrosulphonic compounds, separation of the L salt takes place slowly as the solution cools and the salt crystallises in white scales which can be recrystallized from hot water. The B compounds remains in solution. It may also be noted that under certain experimental conditions L ionone dominates the commercial ionone ; whereas under other set of conditions B ionone is present in greater quantities than L ionone in the mixture.

Phenyl Ethyl Methyl Ether.

Phenyl ethyl methyl ether is a colourless liquid having fine kewda fragrance. It is present in the natural kewda flower oil to the extent of about 70 per cent. It boils at 192-3 degree C. and has specific gravity 0.9417 at 27 degree C. and Refractive Index 1.497 at 24 degree C.

It is prepared by methylating B phenyl ethyl alcohol with reagents such as Dimethyl sulphate, methyl Iodide and Sodium methylate, methyl Iodide and Silver oxide and also by interaction of benzyl Magnesium bromide with bromoethyl ether. In this laboratory the ether was prepared by gently refluxing phenyl ethyl alcohol (1 mol.) for six hours with methyl Iodide (3 mol.) and Silver Oxide ($1\frac{1}{2}$ mol.). After which the reaction mixture was filtered and the filtrate fractionated. The fraction boiling between 190–95 degree C. was taken. The yield was 80–85% of the theoretical.

Note—Read L as Alpha and B as Bita.

The essential oil Research Committee under the Council of Scientific and Industrial Research, New Delhi have appreciated the work and on the recommendations of the Committee, the Board of Scientific and Industrial Research have sanctioned a scheme "Development of Rose Oil Industry in India." The work on this scheme is being carried out at H. B. Technological Institute in collaboration with the Director, National Botanical Gardens, Lucknow.

With a view to develop the essential oil industry in the State, the U. P. Scientific Research Committee have financed the following research schemes to be worked at the Institute :

1. Cultural experiments on vetiver plants and extraction and analysis of the oil at various stages of growth in order to study the period maturity.
2. The estimation of various constituents present in essential oils by chromatographic methods.
3. Development of Rose Oil Industry in India.

The essential oil Research Committee under the Council of Scientific and Industrial Research held its meeting in December 1953. The Chairman of the Committee along with other members visited the Laboratories and gardens under the scheme. They very much appreciated the work.

Benefits to the Industry.—Several new ottos and oils have been prepared and they have provided additional sources of income to the State perfumers. Mention may be made of the Ottos of Kewda and Bela, which were much appreciated in the British Industries Fair 1950. A firm in Kanauj exports these ottos to foreign countries Spearmint oil prepared by us created great possibility for its expansion in the country. A firm in U. K. was willing to purchase 2-3 tons of the oil per annum.

Pepermint oil prepared from the leaves grown at this Institute was very much appreciated by tobacco delears at Banaras for perfuming tobacco. A pharmaceutical firm in Calcutta is willing to purchase 250 lbs. of peppermint oil per annum.

The cultivation of peppermint and camphor bearing ocimum is noteworthy because it will help in restricting their import and in course of time we may be independent of their supply from foreign countries. A number of perfume bearing plants, e.g., palmarosa, lemongrass have been successfully cultivated in the State and the optimum conditions for their growth have been studied. The cultivation of these plants and the extraction of oil from them will give employment to a number of persons and also to farmers who are free for half the year round. The modified method devised for the extraction of otto has enabled the perfumers to prepare ottos on a Cottage Scale.

An improved still has been designed and a few firms have built similar stills.

The chemical examination of various essential oils have assisted in drawing up the specifications of various oils.

List of papers published on Essential Oils

1. Chemcial examination of the essential oil from the peals of Malta oranges by D. R. Dhingra, G. N. Gupta and B. P. Srivastava, Proc. Oil Tech. Association India, 1947, 3, 16.

2. A new method for the manufacture of Otto or absolute by Dr. D. R. Dhingra, G. N. Gupta and J. C. Jain, Proe. Oil Tech. Association India, 1949, 5, 32.

3. Chemical Examination of the Essential Oil from the peels of citrus aurantium or Karna Khatta by D. R. Dhingra, G. N. Gupta and Ganesh Chandra, Indian Soap Journal 1951, 16, 215.

4. The Otto of Pandanus Oderatissimus L. or Kewda by Dr. D. R. Dhingra, G. N. Gupta, U. N. Shukla and J. C. Jain. Perfumery and Essential Oil Record 1951, 42, 114.

5. The Otto of Jasminum Grandiflorum or Chameli Part I and Part II by D. R. Dhingra, G. N. Gupta and J. N. Mehrotra, Indian Soap Journal, 1951, 16, 235 ; *ibid* 1951, 16, 259.

6. Peppermint oil and the possibility of its cultivation in Uttar Pradesh by D. R. Dhingra, G. N. Gupta and J. N. Mehrotra, Indian Soap Journal, 1951, 17, 43.

7. Camphor and camphor oil from ocimum kilimandscharium by D. R. Dhingra, G. N. Gupta and T. N. Ganjoo, Indian Soap Journal 1951, 17, 85.

8. The oil of cyperiol by G. N. Gupta and Ganesh Chandra, Current Science, 1951, 20, 273.

9. The Otto of Juhi (Jasminum Auriculatum) by D. R. Dhingra, G. N. Gupta and B. N. Gupta, Perfumery and Essential Oil Record 1951, 42, 369.

10. The oil of spearmint by D. R. Dhingra, G. N. Gupta and B. N. Gupta, Soap Perfumery and Cosmetics 1952, 25, 279.

11. The conditions of Essential Oil Industry in far Eastern countries by G. N. Gupta, Indian Soap Journal 1952, 17, 212.

12. The Indian Vetiver Oil Industry with special reference to Uttar Pradesh by D. R. Dhingra, G. N. Gupta and Ganesh Chandra. Indian Soap Journal 1952, 18, 3.

13. The Otto of bela or Jasminum sambac by D. R. Dhingra, G. N. Gupta and U. N. Shukla, Perfumery and Essential Oil Record, 1953, 44, 11.

14. Oil of Champaca by D. R. Dhingra, G. N. Gupta, and U. N. Shukla, Atherischeole, Riechstoffe Parfumerien Essenzen Aromen, May 1953, p. 99.

15. Palmarosa Plantation in Uttar Pradesh by G. N. Gupta, Ganesh Chandra and B. N. Gupta, Journal of Scientific Society H. B. Technological Institute and Indian Institute of Sugar Technology, 1953,2, 30.

16. The production of lemongrass oil in Uttar Pradesh by G. N. Gupta and Ganesh Chandra, Indian Soap Journal, 1953, 19, 8.

17. Chemical Examination of some new Indian Essential oils G. N. Gupta, Ganesh Chandra and K. N. Nautiyal, Perfumery and Essential Oil Record 1954, 45, 80.

18. Essential oil of Ocimum basilicum by D. R. Dhingra, G. N. Gupta and S. N. Dhingra, Indian Soap Journal 1954, 19,251.

19. The manufacture of agarbattis by G. N. Gupta and J. N. Tandon Indian Soap Journal 1954, 20, 49.

20. The essential oil of Kewda by S. N. Dhingra, G. N. Gupta and D. R. Dhingra, Perfumery and Essential Oil Record 1954, 45, 219.

21. Chemical examination of the essential oil from marigold flowers by D. R. Dhingra, G. N. Gupta and Ganesh Chandra, Journal, Scientific Society, H. B. Technological Institute and Indian Institute of Sugar Technology, 1954, 3. p. 4.

A scheme for the manufacture of Agar-battis.—The number of agarbattis that can be prepared from 1 lb. of the composition = 2,800 to 3,000 i.e. 19-20 gross. The composition of coating has already been given.

For perfuming the composition, the beginner is advised to buy perfumes from the market.

Costing .—Allowing for wastage etc. of the material 16 gross will be made from one lb. Assuming that 100 gross of agarbattis are prepared per day, the composition required would be 6.5 lbs.

This would ental the following expenditure.

	Rs.	a.	p.
Cost of 5 lbs. of finely powdered exhausted sandal wood at $1^1/_2$ annas per lb. ..	0	7	6
4/5 lbs. of Gum Acacia at 1/4/- per lb.	1	0	0
4/5 lbs. of resinoids at 1/-/- per lb.	0	12	0
Cost of perfume blend at 40/- per lb.	5	0	0
Cost of 100 gross of sticks at -/12/- per 1000	14	6	0
Labour and supervision charges per day	18	0	0
Interest on capital investment on Rs.2,000	0	8	0
Depreciation charges on equipment costing Rs. 200 at 10 % per annum ..	0	1	0
Charges for cardboard packing including printing	8	0	0
Other misc-llaneous expenses including building rent etc.	1	4	0
Total	49	7	0

Taking the total expenses to be Rs.50, the cost of production including packing etc. comes to annas eight per gross which shows that there is an ample margin of profit. If the selling price of 1 gross of sticks be taken as annas ten the profit per day would come to Rs.12-8.

A Scheme for the manufacture of Camphor and camphor oil from Ocimum leaves (Ocimum Kilimands-Charicum)

The following calculations are based on the assumption that the average yield of dried leaves per acre is 2,000 lbs. per annum and the average yield of camphor and camphor oil from the dried leaves is 3.4 per cent. The crude mixture of camphor and camphor oil contains 56 per cent. of camphor and 44 per cent. oil.

Let 10 mds. of dried leaves be distilled per day.

Equipments—

1.	Distillation still capacity 50 gallons fitted with condenser	2
2.	Receivers capacity 50 gallons	6
3.	Sublimation apparatus capacity 5 lbs.	1
4.	Boiler small (3 H.P.)	1
	Total cost of equipment Rs.	25,000

Cost of production per day—	Rs.	a.	p.
Cost of 10 mds. of dried leaves at Rs.4 per maund	40	0	0
Cost of fuel 6 mds. ; at Rs.1-4 per maund	7	8	0
Cost of water	5	0	0
	52	8	0

Labour and Supervision charges :			
6 labourers at 1-8 per day	9	0	0
One Supervisor at Rs. 150 p.m.	6	0	0
One Assistant Supervisor at Rs. 100 p.m.	4	0	0
One peon at Rs. 50 p.m.	2	0	0
	21	0	0
Depreciation charges on Rs.25.000 at 10 % per year	10	0	0
Interest on capital at 5%on Rs.40,000	8	0	0
Total ..	18	0	0
Total cost per day	91	8	0

The total weight of camphor and camphor oil would be 26·24 lbs.from which 14·6 lbs. will be crude camphor.

After sublimation the wight of refined camphor would be about	13·5 lbs.		
Cost of 13·5 lbs. of camphor at Rs.5 per lb.	67	8	0
Cost of 11·5 lbs. camphor oil at Rs. 2-8 per lb.	28	12	0
	96	4	0

The total profit per day would be Rs.5 nearly. Though there is very little profit, but it establishes an industry. There will, however, be some difficulty about the raw material, as the return per acre per year is only Rs.100, therefore it could be cultivated on sandy and unfertile land where there are no facilities for irrigation etc.

A scheme for the manufacture of Vetiver Oil.

The costing of Vetiver oil is based on the assumptions that the yield of oil is 0.20 per cent. (or $6\frac{1}{2}$ tolas per md.) and is prepared on the cottage scale.

A set of 12 stills capable to distil one maund each of vetiver roots is an economic unit.

	Rs. as. p.	Rs. a. p.
Equipment—		
Cost of 12 stills capable to hold 1 maund of roots ..	4,500 0 0	0 0 0
Cost of 40 receivers capacity 60 lbs. each ..	5,000 0 0	
Tanks and separators etc.	500 0 0	
Total ..	..	10,000 0 0
Costing per day—		
1. Cost of 12 mds. of *khas* roots at Rs. 6 per maund ..	72 0 0	
2. Cost of fuel at Rs. 2-8 per still	30 0 0	
Total ..	..	102 0 0
Labour and Supervisions—		
One supervisor at Rs. 150 p. m.	5 0 0	
One skilled labourer at Rs.3 per day	3 0 0	
12 Labourers at Rs. 2 per day	24 0 0	
Total ..		32 0 0
Depreciation charges on Rs. 10,000 at 10 % per annum	3 5 4	
Interset on the capital Rs.20,000 at 5% per annum ..	3 5 4	
Miscellaneous expenses per day	4 5 4	
Total ..		11 0 0
Total expenses per day		145 0 0

From 12 mds. roots, 1.96 lbs. of khas oil will be produced.

Therefore cost of 1 lb. of vetiver oil comes to Rs.74 per lb.

A Scheme for the preparation of perfumed waters and attars.

Assuming that a charge of 10 lbs. attar would require 15 days and 5 mds. of rose flowers ; therefore in one month 20 pounds of attar will be ready using one still i.e. 40 lbs. by using two stills.

Equipment—		
4 Copper stills capacity 2 1/2 mds.	1,500 0 0	
12 receivers	1,500 0 0	
Total	..	3,000 0 0

Out of the four stills, two will be utilised for making attar and the other two for making perfumed waters.

Costing for attars —

	Rs. as. ps	
Cost of 20 mds. rose flowers at 40 per maund ..	800 0 0	
Cost of 40 lbs. sandal wood oil at 40 per lb. ..	1,600 0 0	
Total ..		2,400 0 0
Cost of fuel at Rs. 5 per day	150 0 0	
One skilled labour at Rs. 3 per day	90 0 0	
Tow ordinary labourers at Rs. 2 per day ..	120 0 0	
Depreciation on equipment costing Rs.1,500 at 10 % per year.	12 8 0	
Interest on Rs.6,000 at 5% per year ..	25 0 0	
Miscellaneous expenses ..	52 8 0	
Total ..		2,850 0 0

As there are 34 tolas in one lb ; 1360 tolas attar would be prepared ;—

Therefore, cost of 1,360 tolas attar ..	2,850 0 0	
Therefore, cost of attar per tola ..	2 2 0	including the cost of packing etc.

This attar can be safely sold at Rs. 3 per tola and therefore there will be a net profit of Rs.1,130 in one month.

Costing for perfumed waters —

Cost of 60 mds. rose flowers at Rs. 40 per maund ..	2,400 0 0	
One skilled labour at Rs. 3 per day ..	90 0 0	
Tow ordinary labourers at Rs. 2 per day	120 0 0	
Cost of fuel at Rs. 5 per day ..	150 0 0	
Depriceation on equipment costing Rs.1,500 at 10% per year.	12 8 0	
Interest on Rs.6,000 at 5% per year ..	25 0 0	
Miscellaneous expenses	52 8 0	
Total		2,850 0 0
Cost of 60 drums at 5 each	300 0 0	

Sixty drums of 5 gallons each of one mana rose water will thus be prepared.

The present cost of one 5 gallon drum of rose water (one mana) is Rs.80 including the container which costs Rs.5 each.

Therefore, there will be a net income of Rs. 1,650 in one month

A scheme for the manufacture of peppermint oil from Mentha Piperita leaves.

The following calculations have been made on the assumption that 50 mds. of dry leaves would be obtained per acre per year and the average yield of oil is 0.80 per cent. on the weight of dry leaves and 10 mds. of leaves are distilled per day.

Equipment—

Distillation still capacity 50 gallons fitted with condenser ..	2
Receivers, capacity 10 gallons	6
Boiler small 3 H.P.	1
Total cost of equipment	Rs. 20,000

Cost of production per day—			Rs. a p	Rs. a p
Cost of 10 mds. of dry leaves at Rs.4 per maund	..	..	40 0 0	
Cost of fuel 6 mds. at Rs. 1-4 per maund ..	..	..	7 8 0	
Cost of water etc.	..	..	5 0 0	
	Total		..	52 8 0
Labour and Supervision charges :—				
6 labourers at Rs. 1-8 per day.. ..	..	..	9 0 0	
One supervisor at Rs. 150 p.m. ..	..	..	6 0 0	
One store-keeper-*cum*-clerk at Rs. 100 p.m. ..	..	..	4 0 0	
Depreciation charges on equipment costing Rs.20,000 at 10% per year			7 0 0	
Interest on capital Rs.30,000 at 5% per year	..	..	5 0 0	
Miscellaneous expenses	..	..	1 8 0	
	Total		..	32 8 0
	Grand Total		..	85 0 0

The total yield of oil per day would be 6.5 lbs.

Cost of oil per lb.=Rs.14 approximately.

If it is sold @ Rs.16 per lb. there can be saving of Rs.13 per day.

The following are the percentage yields of oils in various plant materials which have been studied at H. B. Technological Institute, Kanpur.

Name	Botanical name	% yield of oil
1. Bela	*Jasminum Sambac* ..	0·02—0·022%.
2. Chameli	*Jasminum Glandiflorum* ..	0·02—0·025%.
3. Champa ..	*Michelia Champaca* ..	0·06—0·07%
4. Harsinghgahr ..	*Nyctanthes Arbortristes* ..	0·0045%
5. Juhi ..	*Jasminum Auriculatum* ..	0·025—0·03%
6. Kewda	*Pandanus Odoratissimus* ..	0·015—0·03%
7. Kadamb	*Anthocephalus Cadamba* ..	0·0075%
8. Moulsari ..	*Mimusops Elengi* ..	0·01%
9. Marigold yellow ..	*Tagetes Erecta* ..	0·016—0·018%
10. Marigold red ..	*Tagetes Patula* ..	0·018—0·02%
11. Night Queen ..	*Cestrum Nocturnum* ..	0·012—0·014%
12. Sweet Basil ..	*Ocimum Basilicum* ..	0·3—0·4%
13. Rose Edwards ..	*Rosa Bourbonica Hybrid* ..	0·01—0·015%
14. Rose Easli ..	*Rosa Damascena Mill* ..	0·015—0·02%
15. Rose Teplitz ..	.. ..	0·01—0·12%
16. Rose His Majesty ..	.. ..	0·015%

Name	Botanical Name	Yield of oil
Leaves—		
1. Black berry leaves ..	.. *Eugenia Jambolana*	.. 0·013%
2. Camphor bearing Ocimum	.. *Ocimum Kilimandscharicum*	3—3·4%
3. Karna Khatta ..	.. *Citrus Aurantium*	.. 0·25—0·28%
4. Lemongrass ..	.. *Cymbopogon Flexus*	.. 0·14—0·22%
5. Lemonleaves (Sweet)	.. *Citrus Limettoides*	.. 0·18%
6. Mangoleaves ..	.. *Mangifera Indica*	.. 0·02—0·027%
7. Marigold Yellow ..	.. *Tagates Erecta*	.. 0·05—·07%
8. Marigold red ..	.. *Tagetes Patula* ..	.. 0·09—0·1%
9. Narangi	.. *Citrus Reticulata*	.. 0·315%
10. Palmarosa (Motia)	.. *Cymbopogon Martini (Var. Motia)*	0·15—0·17%
11. Palmarosa (Sofia) ..	.. *Cymbopogon Martini (Var Sofia)*	0·1—0·12%
12. Peppermint (American) ..	.. *Mentha Piperita*	.. 0·2—0·25%
13. Peppermint (Indian)	.. *Mentha Piperita* ..	.. 0·2—0·25%
14. Sweet Basil ..	.. *Ocimum Basilicum*	.. 0·18- 0·24%
15. Spearmint ..	.. *Mentha Spicta* ..	.. 0·2—0·25%
16. Tejpat	.. *Cinnamomum Jners*	.. 0·73—0·85%
Miscellaneous—		
1. Nagarmotha ..	.. *Cyperus Scariuses*	.. 0·29—0·35%
2. Vetiver (Khas roots)	.. *Vetiveria Zizaniodes*	.. 0·08—0·31% Northern India.
3. Vetiver (Khas roots) ..	.. *Vetiveria Zizanioides*	.. 0·31—0·41% South-India.
4. Sandal wood ..	.. *Santalum Album*	.. 2·5—3·0% Jhansi.
5. Ajowain Seeds ..	.. *Ptychotic Ajowain*	.. 2·45%
6. Aniseed ..	.. *Pinpinella Anisum*	.. 0·22—0·23%
7. Cumin seeds ..	.. *Carum Carvi* ..	.. 1·57—2·04%
8. Coriander (Dhamia) ..	.. *Coriandrum Sativum*	.. 0·06—0·08%
9. Dill seeds ..	.. *Anethum Sowa*	.. 2·0—3·1%
10. Sugandhawala ..	.. *Pavomia Odorata*	.. 0·53%

Future plan of the work.

1. Cultivation of some perfume bearing plants which would be imported either from foreign countries or from other States. Mention may be made of Levender, Patchouli, Geranium and Cananga plants from South Indian States and Peppermint plants and seeds from U. S. A. or Japan and vetiver plants from Indonesia.

2. Experiments will also be made to grow special variety of roses by grafting and cross breeding.

3. Manurial experiments on different varieties of materials will be tried and the yield studied.

4. Cultural experiments of vetiver plants will be conducted using different varieties of vetiver plants.

5. Cultivation of special variety of coriander, cumin, aniseed and ginger etc.

6. Cultivation of camphor bearing ocimum in usar lands.

7. Preparation and extraction of essential oils from the above plants and also from other plants not so far worked out.

8. Preparation of oils from different spices and other perfume bearing plants.

9. Chemical examination of the new oils and ottos.

10. Blends for sundry cosmetics viz. hair oils, creams, tobacco, soaps and face powders etc.

11. Preparation of aromatic chemicals.

12. Preparation of essences for aerated waters and confectionary goods.

13. Examination of various types of attars for their standardisation.

Conclusion

It might have been observed that some natural oils e.g. Lavendar, lemon, clove, camphor, eucalyptus, peppermint, patchouli and bergamot oils are imported into the country. As India has a variety of climatic conditions and soils suitable for the growth of aromatic plants, attempts have been made in this direction since long but the commercial exploitation has not yet been started systematically. It may be mentioned in this connection that a few varieties of Lavendar have been grown in the lower altitudes of Nilgiris and Sheveroy hills. Clove trees have been grown in Travancore Cochin and the possibility of their cultivation in other places has also been surveyed by the Indian Council of Agricultural Research New Delhi.

Under the auspeces of the Essential Oils Research Committee the cultivation of patchouli plants has been taken up at Banglore. The U. P. Government has been trying to cultivate Patchouli, ylang ylang, peppermint, lavendar plants etc,, in the State on commercial scale.

The Forest Research Institute Dehradun has also contributed a good deal towards the cultivation of aromatic plants and the analysis of their essential oils in U. P.

The Essential Oils Research Committee have proposed to spend large sums of money to devise a machine for the extraction of orange oil from their peels in Madhya Pradesh. A special variety of eucalyptus (E. Citrodora) containing a high percentage of citronellol in its oil is being cultivated on a small scale in Calicut.

As regards aromatic chemicals plenty of work has been done in various laboratories in India. Mention may be made of the National Chemical Laboratories, Poona, Indian Institute of Science, Bangalore, Delhi, Calcutta Universities and H. B. Technological Institute, Kanpur. The Government of India are also imposing restrictions on the import of synthetic essential oils so that their production in the country may be encouraged.

The standardisation of important essential oils produced on a commercial scale in India has also been started and standards for India Palma Rosa, lemongrass oil, sandal wood oil Eucalyptus oil etc. have been drawn by the Indian Standards Institute Delhi and the Standard specifications for other oils are being drawn. This standardisation will improve the export trade of the country and the consumers will now get the genuine oils for industrial purposes.

Considering the progress in various States and by different agencies towards the cultivation of aromatic plants in the country and the preparation of aromatic chemicals and synthetic essential oils it is expected that during the next five years plan, the country may become independent of foreign supplies.

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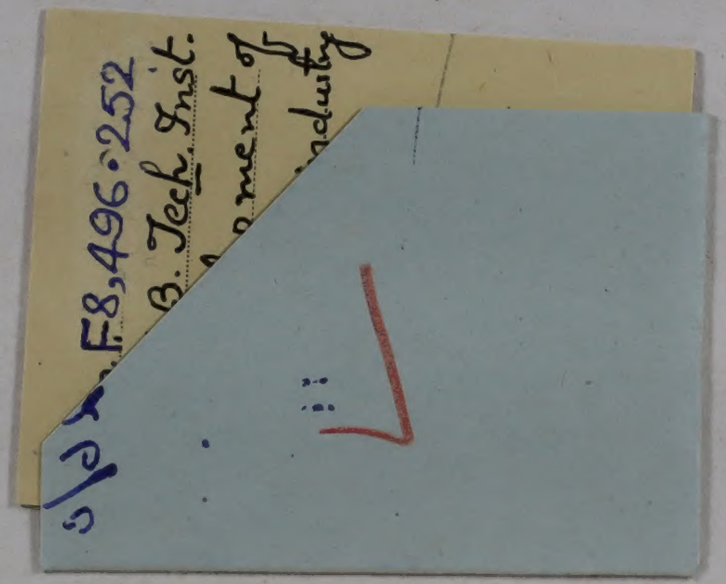

I appreciate very much if you could bestow your valuable time on this so that the ultimate purpose is achieved.